RUBBER MACHINERY

An Encyclopedia of Machines Used in Rubber Manufacture. Crude Rubber Washing, Drying, Preparing of Ingredients, Mixing, Preparing of Fabrics, Calendering, Vulcanizing; Calenders, Drives and Safety Stops; Presses and Molds; Spreaders and Tubing Machines; Machines Used in the Manufacture of Reclaimed Rubber and Cements; Temperature Regulating Devices; Extracting Machines for Wild Rubber, for Deresination; Laboratory Equipment, Testing Machines and Devices, etc.

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To the Inventors and Builders
of Rubber Machinery
Whose Mechanical Genius has Transformed
a Hand Process Industry
into one in which
Labor Saving Machinery is the leading factor.

PREFACE

FOR more than fifty years mechanical and inventive ingenuity has been producing machinery for use in rubber manufacture. In crude rubber washing, mixing and calendering the problems were once thought to be comparatively simple and their solution about the same the world over. Today, however, scores of new and more efficient machines handle new gums and intricate compounds, and the simplicity disappears. Even in the preparation of the crude material for market, machinery is to a marked degree supplanting hand labor.

Rubber manufacture, be it noted, divides itself into some thirteen well defined classes. In these lines there are certain basic processes that all use—washing and mixing, for example. It is true, also, that most of them make cements, for their own use at least; that a great number use tubing machines; that spreaders are used by others than "proofers," and so on. The object of this volume is to record the machines that are of general application either to all or to a number of the lines into which the trade is divided.

To this end voluminous matter has been collected from machinery makers the world over; from rubber factories, from patent specifications—American, English, German and French. The actual value of such a collection to the rubber manufacturer, whatever his line, should be great, but the suggestive value will be even greater.

To the manufacturers of rubber machinery in the United States, England, Germany, France and Belgium, the author takes the opportunity to express his thanks. Their generous promptitude in furnishing photographs, blue prints and details of special machines has made the task of arrangement and description much easier and the book far more complete than it could otherwise have been.

The files of the "India Rubber Journal," and "Gummi-Zeitung" and "Le Caoutchouc et la Gutta Percha" have also been of definite assistance in the collection of material, and my debt to these excellent journals is gratefully acknowledged. The members of my staff, also, and various rubber engineers have materially lightened the labor of putting the subject matter into shape.

That there is much yet to be done ere rubber processes are mechanically perfect none will deny. If, therefore, by recording what has been done the writer is able to help the rubber trade toward greater triumphs, his aim will have been accomplished.

HENRY C. PEARSON

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CHAPTER I.

THE WASHING OF CRUDE RUBBER.

CRUDE rubber (wild) as it comes to the market appears in a great variety of forms—hams or pelles, balls, strips, sausages, lumps, flakes and all conditions of scrap. This rubber is packed in rough boxes, in casks and in bales. The manufacturer, on receiving a lot, at once opens the packages, weighs and tares them. Each lot is stored separately, preferably in bins on the ground floor of the store-room which should be as near as possible to the wash room. Storage rooms for rubber should be fireproof, dark and cool. There is no necessity for them to be damp. Cement floors are the best and should be channeled to allow the water that drips from the rubber to run away. Pelles of fine Para can be put in heaps of almost any size, indeed, in case of fire a big heap is a protection as the mass will glaze over with melted rubber and the interior be saved. For lower grades of rubber it is well to have the bins shelved so that the rubber cannot heat and further deteriorate. Each lot should be tagged and record kept as to condition and weight, and followed through the wash room and drying room, that handling, shrinkage, etc., may be known and the cost accurately estimated.

In all wild rubber there is more or less foreign matter that must be removed before the rubber can be used in manufactured goods. The foreign substances are bits of bark, leaves, splinters of wood, sand, fibre, earthy matters, etc., etc. The only exceptions to this very general rule are deresinated and plantation rubber. Many manufacturers find it worth their while to wash even these sorts, as the process seems to result in a better and tougher product. The primary process, whatever the line of rubber manufacture, therefore, is that of washing. This is really most important, for the cleaner the rubber the better the manufactured product. The wash-room employs heavy machinery, hot and cold water and steam, and is, therefore, a sloppy, dirty department, the air full of vapor and often smelling vilely. It is, therefore, preferably separated from all other departments. The workmen usually wear rubber boots and rubber aprons, and for tools have bale hooks, big knives and shovels which are used only at intervals.

Softening Tanks.

Crude rubber in pelles, lumps, etc., is often particularly hard and intractable. It could be torn to pieces by machines, but at the expense of much power and frequent breakages. It is, therefore, first softened

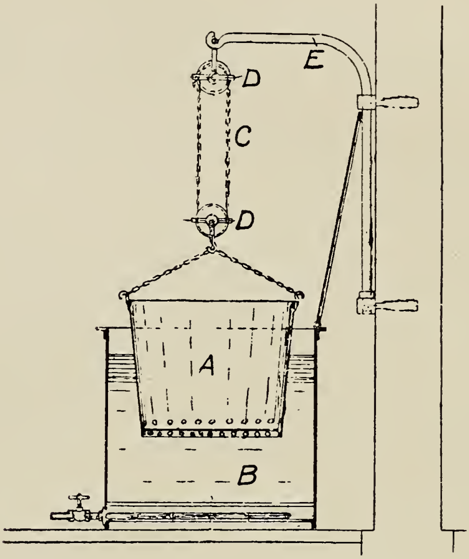


Fig. 1.—Softening Tank and Cage.

by immersion in warm water. For this purpose great vats, called by the English, Pickling Tanks, are constructed so that they can be filled with water and the water heated by steam jets. These tanks are usually built according to the ideas of the users. Some have the top flush with the floor, and some rise five or six feet above it. Sometimes they are of plank, other times of iron. Some are open at the top, others closed. It does not matter much which forms are followed, provided they are set to fill conveniently from the storehouse, and be emptied just as conveniently for the washers.

In Fig. 1 is shown one form of tank which is used in a number of rubber factories, especially in Germany. Instead of throwing the raw rubber directly into the tank of warm water, it is placed in a perforated bucket *A* and lowered into the warm water in the tank *B*, where it is left for a sufficient length of time to prepare it for working. Where the quantities of rubber necessitate a tank of large size, the weight of the bucket will call for some mechanical means of raising and lowering it into the tank. This is done by means of a chain

C passing over pulley blocks *D*. Provision may be made for swinging the supporting arm *E* to one side of the tank, or the latter may be mounted on rollers for pushing it to one side, so that the bucket may be lowered to the floor. There is the temptation on the part of manufacturers to heat the rubber in these vats too much. Indeed, some of the poorer grades scarcely need such a process. For the better grades it should be remembered that once the rubber is permeated by the heat, and three or four hours should be enough, it should go at once to the washer. A longer immersion is very apt to notably subtract from the nerve of the rubber.

Cutting and Shredding Machines.

Washing has as a preliminary, not only the softening but the shredding of the gum, that the water can get at the imprisoned particles

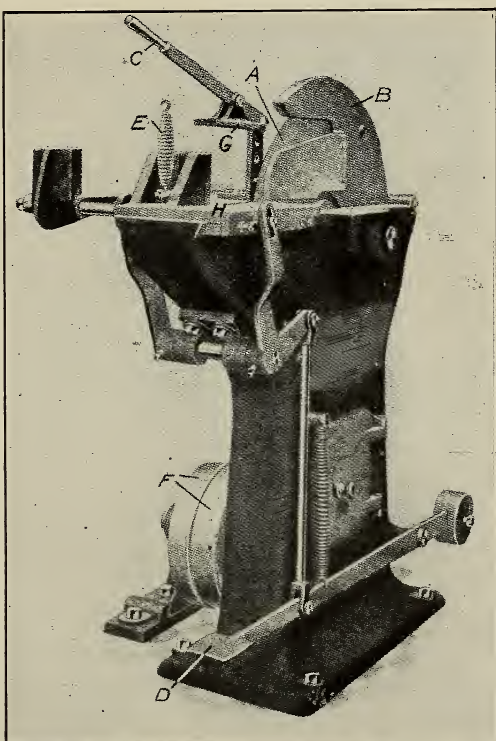


Fig. 2.—Power Knife for Cutting Rubber.

of dirt and free them. This shredding is done by cutting and tearing. For the larger pieces a power driven circular knife is used.

The modern cutting machine for doing this work is shown in Fig. 2. At *A* is shown a large circular knife protected on the top and rear by a guard *B*. *C* is an adjustable hand lever with a plate *G* by means of which lumps of rubber of any size may be held down against the table *H*. By means of the spring *E* the lever is held down while the rubber is being cut. The knife is operated by pulley *F*, tight on its shaft, the other pulley being loose to allow the machine to be thrown out of operation when desired. The table *H* may be moved toward the knife by pressing the foot lever *D*, the table returning to its original position when the lever is released. By the use of this machine the rubber may be quickly reduced to small pieces which are more easily run through the rolls of the washer.

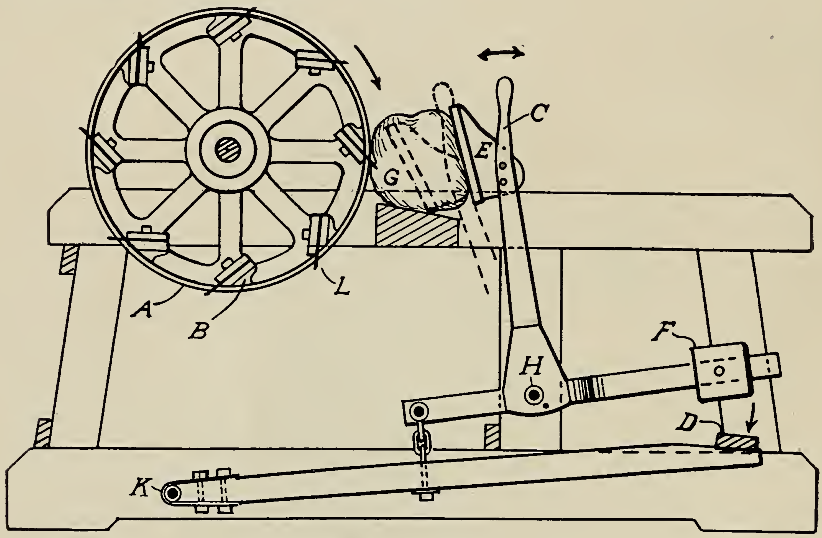


Fig. 3.—Power Shredding Machine.

For fine shredding of pseudo rubbers there is a European machine of value. It is in brief a drum, from the face of which project knife points set obliquely and acting like planer knives; that is, projecting enough to cut only thin shavings. The rubber is sent to the machine as dry as may be. Over the machine, however, is a water jet to help in the cutting and to cool the knives. A lump of rubber is set on the frame of the machine and held against the wheel by a lever on which is fastened a presser plate. The drum revolves at great speed and the lump is forced against it until it is cut into thin shavings. The machine, Fig. 3, in detail is as follows: In the rim or surface of the iron drum *A* are set a number of blades

L in the holders *B*. This drum is eight to ten inches in width and the knives extend through slots in the surface of the drum along almost its entire length. The hand lever *C* is pivoted to the frame of the machine at *H*, and has attached to it a plate *E*, by means of which the ball of rubber *G* is forced against the iron drum as the latter revolves at high speed. In order to increase the pressure at which the rubber is forced against the drum, or to allow the workmen to have both hands free, a pedal *D* is attached to the base of the frame and pivoted at *K*. When the pedal or hand lever is released, the weight *F* is sufficient to pull the plate *E* back from the drum, thus allowing a new ball of rubber to be inserted. The shreds of rubber, as they are cut from the ball, are caught in any suitable container placed under the drum. A stream of water from an overhead pipe is allowed to run upon the rubber in front of the blades in order to facilitate the cutting.

The rubber when not thus cut is fed first into the cracker-washer. The action of this machine is to tear or mangle the rubber, releasing the dirt and bark, which are washed away during the operation by a stream of cold water, which plays upon the mass. The cracker-washer is a heavy, two or three-roll type of machine, the size and number of rolls depending on the quantity of material to be handled.

From it the partially cleaned rubber then passes to the two-roll washer (or to the tub washer). The province of the two-roll washer is to complete the washing process and to sheet the torn rubber. Warm water is used on the mass to produce a degree of stickiness, that the action of the rolls may form it into sheets. Cold water is then turned on and the sheets passed through the rolls repeatedly until completely cleansed by the kneading action of the rolls and the running water.

Two-Roll Washers.

There is a great variety of washers in use in the world's rubber mills, but a majority of them are of practically the same design; that is, they are usually two-roll machines, the rolls geared in different speeds and running toward each other. In rubber plantations practically the same type of a machine is used, run either by hand or by power, and in some of the larger plantations batteries of machines are employed. As plantation rubber is washed very soon after coagulation, the machine may be quite light and does not take nearly the amount of power to run that the same types in rubber factories call for. It should be remembered that wild rubber shrinks anywhere from 12 to 50 per cent., and that while a considerable percentage of this shrinkage is due to the water extracted from the gum, a great deal is foreign

matter, more or less injurious. It will at once be asked why manufacturers have not insisted upon rubber being washed at the source of supply and delivered clean and dry, thus saving much in the way of freights. The explanation is that as soon as rubber is washed and perhaps massed and its physical aspect changed, it is so easy to amalgamate inferior and superior qualities that manufacturers decline to take the risk of being cheated, and have consistently frowned upon all such suggestions. There have been, however, and still are, crude rubber washing companies in various parts of the world that have done a fair business, but none of them have been conspicuously successful as yet.

There are at present some forty companies in the world making roll washers, and their patterns are more or less similar. It will, therefore, be sufficient, in describing these machines, to take examples from the output of any of the higher class of machine manufacturers and describe them as practically typical of the whole.

Roll washers consist of heavy iron rolls running toward one another, set in substantial iron frames, fitted with piping so that hot or cold water may be sprayed over the rubber as it passes between the moving rolls, and with sieve bottoms to save scraps, and guides between the rolls to keep the rubber from working into the bearings. These rolls, be it remarked, are fluted or corrugated so as to bite the often intractable and slippery gum.

Regarding the kind of corrugation, many experiments have been made to determine the best possible form. There is, for example, the saw-tooth corrugation, in some cases both rolls being cut to this shape, while in others one roll is smooth and the other cut. Probably more rolls are made with the V-shaped corrugation than any other. Experiments have shown that this form will do quite as good work at least, as it holds its shape longer and is easier to recut than the other forms. It seems to be quite a question whether two cut rolls or one (one being a smooth roll) will give the better results. There are cases where two cut rolls with ordinary corrugations make good sheets, but in small mills where one machine is required to do all the work from breaking down the biscuit to sheeting out, the machine with one smooth and one cut roll with a friction of about 1¼ to 1 in the rolls, is the better.

Taking a two-roll washer of the standard type, it has about the following description. The frames are heavy in construction, accurately lined and firmly held in place by stay rods. These frames are side-capped, the caps being bolted in place with heavy bolts in order to resist the strain at this point. The journal boxes are solid cast, designed

to keep out water and dirt. The bearing surfaces are channeled to insure perfect lubrication and bronze-lined in the sections exposed to greatest wear. Oiling devices easy and safe of access are provided. The rolls are of hard gray cast iron. The grooves or corrugations of both rolls are milled in spirally about four to the inch. The front or driving roll revolves in stationary boxes. The follower roll is

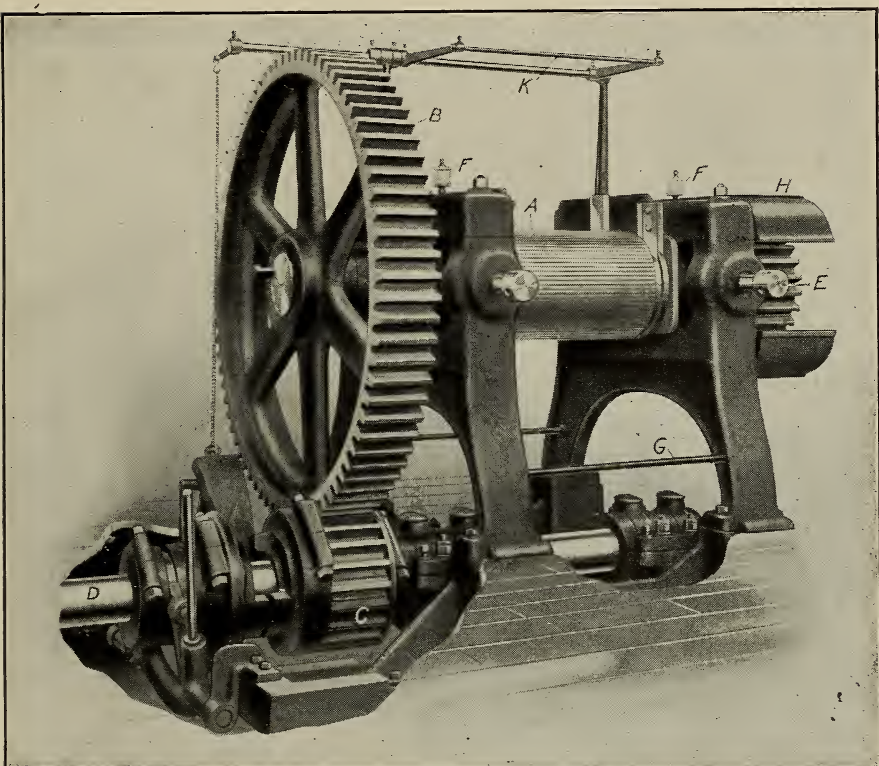


FIG. 4.—TWO-ROLL WASHER.

brought into adjustment by means of steel adjusting screws, working in bronze nuts set into the back of the frames.

The power is ordinarily taken from the main shaft by means of a clutch and pinion. The latter engages a spur gear, keyed to the driving roll. A gear is keyed to the other end of this roll and meshes with a larger gear keyed to the end of the follower roll, causing the two rolls to travel at different speeds. The following are standard sizes of

two-roll washers and their ten-hour product when doing the whole operation of cracking, sheeting and washing.

8 x 16″	2 roll	300	pounds	in	10	hours	7½	H. P.
10 x 20″	" "	500	"	"	10	"	10	H. P.
12 x 24″	" "	900	"	"	10	"	15	H. P.
14 x 28″	" "	1,200	"	"	10	"	20	H. P.
15 x 30″	" "	1,500	"	"	10	"	25	H. P.
16 x 36″	" "	2,000	"	"	10	"	30	H. P.

If these machines received the rubber already cracked, they would do at least 25 per cent. more work. These machines weigh from 10,000 to 23,000 pounds.

Fig. 4 shows a machine that is either washer or cracker as desired. It has two corrugated rolls *A*, placed side by side and driven by the large gear *B* from the pinion *C* on the main driving shaft *D*. The front roll, the one shown in the illustration, is adjusted horizontally by the set screws *E*, and the bearings of the rolls are lubricated from oil cups *F*. The rubber to be washed is placed between the rolls and run over and over the front roll. A removable pan rests upon the cross bars *G*. In it is a screen which catches fragments of rubber, but allows the waste material to fall through to the bottom. It will be noticed that this machine is provided with shields *H* over the gears which drive the second roll, and a safety throw-out device operated by the cross bar *K*, situated conveniently above the machine. This safety device is fully described further on.

The two roll cracker-washer used for cracking alone, the washing and sheeting being done on other machines, is capable of performing an immense amount of work. The following figures are a fair average. A machine 15 inches x 24 inches, 5,000 pounds in 10 hours, horse power used 35; one 16 x 30, 6,500 pounds in 10 hours, horse power used 50.

When used for cracking, washing and sheeting, however, it is practically the same machine as the two-roll washer. It is, however, usual to have the rolls more coarsely corrugated and of chilled iron. The rolls run at the ratio of about 1 to 1½. A cracker-washer with rolls 15 x 24 should deliver 1,500 pounds of stock in ten hours, and take about 25 H. P. to do it. One 16 x 30 should produce 2,000 pounds, and require 30 H. P. One 18 x 36 should deliver 2,500 pounds and use 35 H. P.

Heil and Esch describe a two-roll washer which is used for the final washing and sheeting. It is of light construction and built like a two-roll calender, with one roll above the other. The rolls are not corrugated and the friction is very slight. The water spray is fixed

against the top roll. In operation, the cracked rubber is placed on a table in front of the machine whence it is fed. As the rubber sheets it is caught under the machine by a conveyor belt, while the dirty water runs over a protector that covers this belt and avoids further contact with the washed rubber. Such washers are not used in the United States and their value against the washer with the rolls side by side is problematical.

Three-Roll Washers.

The three-roll washer is designed to handle large quantities of rubber after it has been passed through the "cracker." It has a capacity

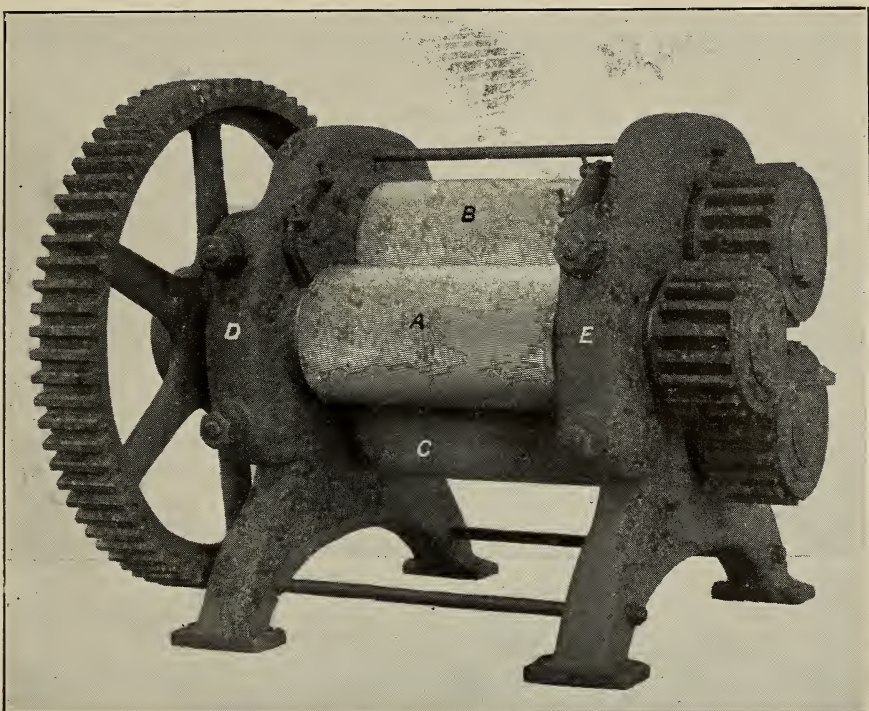


Fig. 5.—Three-Roll Cracker Washer.

nearly double that of a two-roll machine of corresponding size, while only one operative is required. The frames are heavy, strong, should be accurately squared as to each other and securely held in place by strong stay rods or bolts. The caps are located on the front of the frames to facilitate removal of the rolls. They are of heavy construction and provided with strong bolts to resist the powerful thrust

directed against this part of the machine. The journal boxes are solid cast, provided with oiling devices, easy and safe of access, and the inner or bearing surfaces are oil-channeled to insure perfect lubrication, and designed to keep out water and grit. The bearing sections exposed to much wear are bronze-lined.

The rolls are usually solid cast of hard gray iron. The grooves or corrugations of all three rolls are V-shaped, planed in spirally about four to the inch. The front or middle roll is the driver and revolves in stationary boxes. The two follower rolls are brought into adjustment with the middle roll by means of steel adjusting screws, working

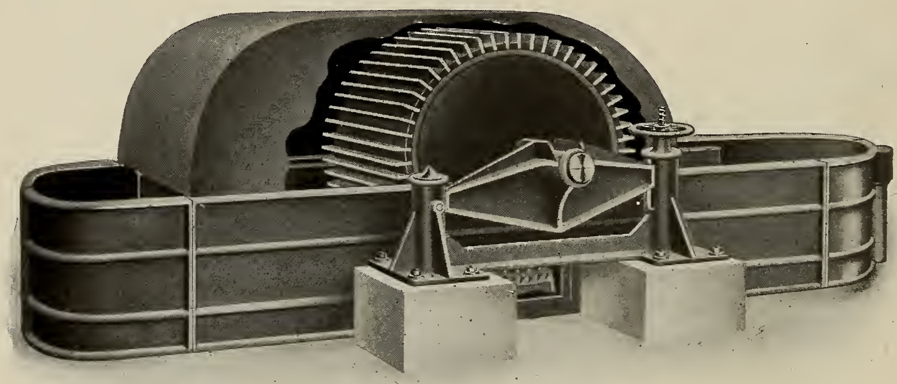


Fig. 6.—The Vaughn Iron Tub Washer.

in bronze nuts set into the back of the frames. Power is applied from the main shaft by means of a jaw clutch and pinion which engages a spur gear keyed to the middle or driving roll. A gear is keyed to the other end of this roll and meshes with similar gears keyed to the ends of the two follower rolls.

Three-roll washers come in three sizes, weighing about 15,000, 18,000 and 25,000 pounds. They have a capacity for ten hours work in cracked Para rubber of 2,500, 3,500 and 4,500 pounds, using all the way from 50 to 100 H. P. If these machines were obliged to do their own cracking the output would be about 25 per cent. less.

The three-roll cracker can be used as a cracker or a cracker-washer. The rolls are usually chilled and provided with coarse corrugations, such as the undercut or saw-tooth spiral shape with the face backed off, and the driving roll is geared to run 1 to 1½ or 1 to 2 as compared to the follower. A steel neck is also recommended for the driving roll.

The three-roll cracker-washer does the entire work from the biscuit or crude material to the clean sheet. The corrugations are usually the V-shape spiral on all rolls, but in some instances the driving roll is corrugated and the follower rolls are smooth. The differential speed of the rolls is 1 to 1½.

This machine is so simple in construction that it needs very little description. The front roll *A* (see Fig. 5) is the driving roll and is mounted in stationary bearings. The other two rolls, *B* and *C*, are provided with adjusting screws (not seen in the illustration), by means of which the rolls may be adjusted horizontally to within any distance of the stationary roll. The caps *D* and *E*, located on both sides of the frame, may be removed for taking down the rolls. The corrugations on the surface of the steel rolls are plainly visible in the illustration.

Tub Washers or Hollanders.

A distinct type of washer has grown up by the side of the roll machine, and is very generally used, particularly in cleaning the softer

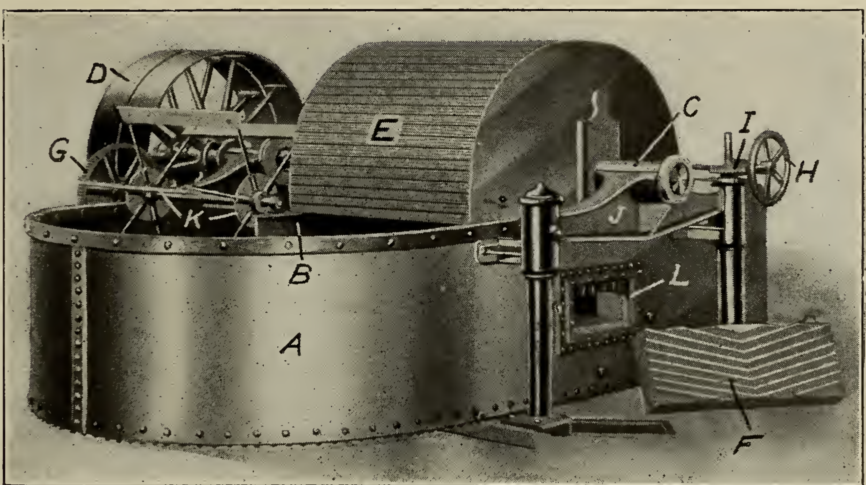


Fig. 7.—The Tub Washer or Hollander.

gums. It is known as the "Tub" washer and is very much like the so-called "paper engine."

It is in brief a tank anywhere from 2 to 16 feet long, with one or two beater wheels running in it. When filled with water and shredded material it runs the contents round and round the tank, beat-

ing and cleansing, and yet never crushing. In use the rubber is first run through a cracker or cutter of some sort and shredded. It is then put in the tub, which has been previously filled with water. When the machine is started the rubber is carried under the washing roll and over the bed plate at the bottom, which spreads and stretches the rubber and releases particles of sand or bark or other foreign matter. The bark, being lighter than the rubber, floats on top and is skimmed off, while the sand and gravel settle to the bottom.

The Vaughn Tub Washer.

In Fig. 7 the tub or tank *A*, which is used in many factories and sometimes on plantations, is divided through its middle by a partition *B* which, however does not extend the full length of the machine but leaves a space at each end for the circulation of water and rubber. Across the top is a shaft *C* driven by the belt pulley *D,* bearing a large washing roller underneath the cover *E*. The bed plate *F,* also bears corrugations or teeth which serve to tear the rubber apart as it passes between the plate and the roller. A countershaft driven from the main shaft by the gear *G* bears a paddle wheel *K*. By means of the hand wheel *H* and worm gear *I,* and the cross yoke *J*, the shaft *C* may be raised so that the distance between the washing roller and the bed plate is varied. When the machine is in use the beater drives the rubber around the tank, stretching it and tearing it between the roller and the bed plate. In this way the heavy foreign substances are released and sink to the bottom where they are separated from the rubber by a screen. This screen is set some distance above the bottom of the tank, about on a level with the lower side of the door *L*. The bark is skimmed off or is carried away through an overflow.

The Bertram Tub Washer.

In Fig. 8 is shown an English type of tub washer in which the principle of operation is almost the same as in the Vaughn described above. It differs, however, in a few details of construction. The machine consists of a cast iron trough *A* made in an oblong form with round ends. Screened sand traps are arranged in the bottom of the trough for the heavier foreign matter. Above the level of the screens is placed a corrugated bed plate attached to the box *B*, which is inserted through an opening in the side of the trough. Above this bed plate revolves a large corrugated roller which is covered by the hood *C*. This corrugated roller is driven by a pulley keyed to the shaft *H*. The distance between the roller and the bed plate is controlled by the hand

wheel *D* to give a greater or less tearing action to the rubber. The rubber is beaten and the dirt and bark are freed by the screened drum

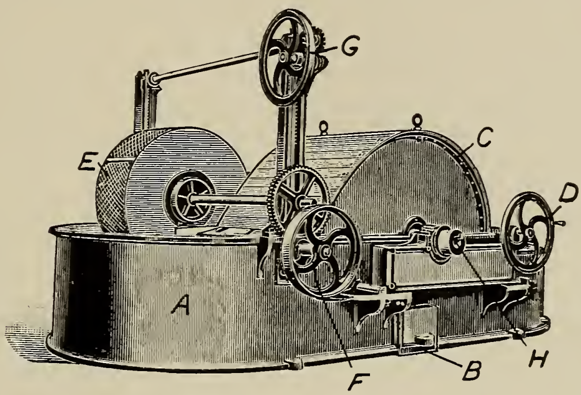


Fig. 8.—The Bertram Tub Washer.

E, the dirty water being delivered over the side of the trough into a suitable trap. This drum is turned by the belt pulley *F* and the amount of water removed can be regulated by lowering or raising the drum by the hand wheel *G*. Such a machine as this is suitable for washing all kinds of shredded rubber, especially those containing a large percentage of impurities.

Universal Washer.

A type of washer which is essentially European is an adaptation of a Masticator. The argument of the inventors is that in ordinary washing with the two or three-roll machines, impurities are all crushed or splintered and held in the rubber, causing a much longer duration of washing than should be necessary, and that this impairs the "nerve" of the rubber.

The machine consists of a pair of deeply corrugated rolls, carried in a trough shaped at the bottom to follow the periphery of the rolls. The trough carries ledges at the back and front, which turn the rubber over and guide it between the rolls. There are gratings in the back and front of the trough, through which the lighter impurities escape.

These machines come in three standard sizes, which take charges of rubber of twenty, forty and eighty pounds. The horse-power required is approximately 9, 15 and 25, and the time required per batch from ten to twenty minutes. The above relate to Para sorts. For low grade gums the charge may be as high as one hundred and fifty pounds.

One of these washers (Fig. 9) described in detail will clearly illustrate the mechanism of all.

The inner trough *A* is fed with lumps of rubber weighing about 10 pounds each. The corrugated rolls *B* revolve toward each other and seize the pieces of rubber, tearing them apart against the saddle *C* and then conveying the pieces up the walls of the trough to the projecting edges of the trough at *D*. This operation is repeated continuously and automatically.

At the bottom of the trough are smaller saddles *E* which give the rubber a turning motion and at the same time release the heavier impurities, allowing them to fall through slots in the bottom of the trough. In order to prevent these slots from clogging, shakers *F* are arranged in them between the saddles.

The main washing trough *A* is surrounded by an outside trough *G*, which is provided with valves *H* and *K* for the removal of dirty water and for the regulation of the water level. Underneath the main trough is a sand tank *L*, having a drain valve *M* and a gate *N*. Located directly above the tank is a pipe *O* from which water is sprayed continuously into the trough to wash away the impurities coming to the surface. At *P* are shown lateral sieves, so proportioned as to allow the passage of the impurities but to prevent the passage of the rubber. For drawing off the coarse substances, larger openings are provided between the stone catch *D* and the comb-like grate *Q*. At the beginning of the washing of certain kinds of rubber, scraps float on top of

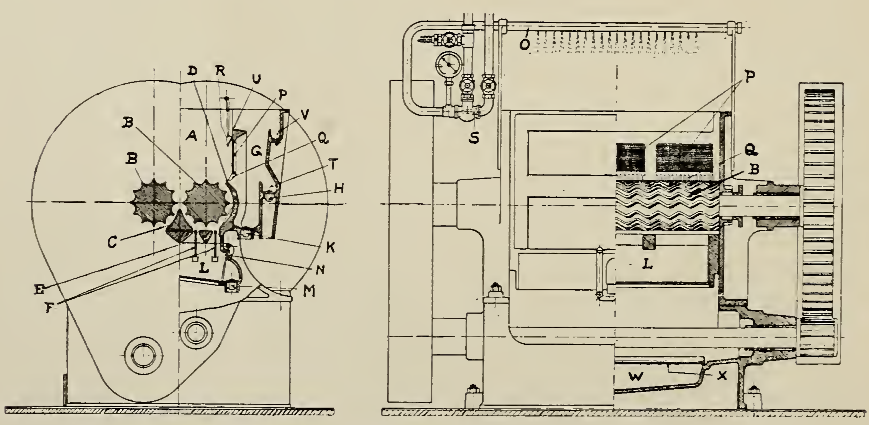


Fig. 9.—Universal Washer.

the water. To prevent them from being carried away as waste material, an adjustable sieve *R* is placed over the grate *Q* until the rolls have

formed this scrap into larger pieces. By the mixing nozzle *S* between the hot and cold water valves, any desired temperature of water may be obtained. Also, by the various outlets, the water level in the

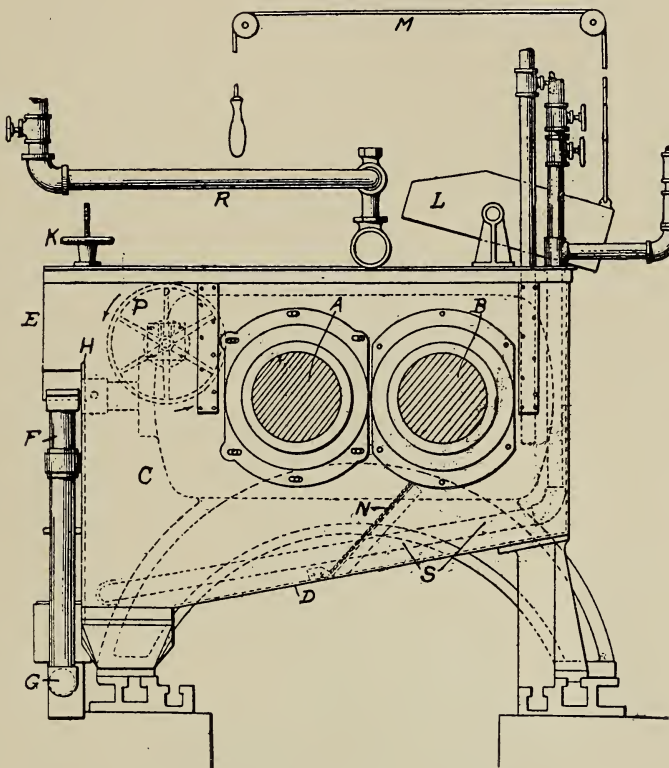


FIG. 10.—THE HOOD ENCLOSED WASHER.

trough may be regulated. For instance, by closing the gate *N* and the valves *K* and *M* and leaving valve *H* open, the water level is raised to the overflow channel *T*. If it is desired to raise the water level still further—which may be temporarily necessary for the removal of pieces of wood from scrap rubbers—the valve *H* is also closed, raising the level to the overflow edge *U* so that the water will drain off through the channel *V*. Underneath the machine is a waste water tank *W* which is connected to a drainage system. In this tank is a sieve *X* which catches small particles of rubber that may have accidentally passed through from the trough.

The Hood Enclosed Washer.

What is known as the Hood washer is a two-roll machine set in a closed tank, so that the level of the water during washing comes above the nip of the rolls. When at work the rubber sheet floats up to the surface and feeds through the rolls automatically. Floating impurities are washed away, while the heavier parts sink to the bottom out of the way and are removed periodically through a gate.

In Fig. 10, which shows an elevation of the machine in cross section, the corrugated rolls *A* and *B* are mounted in a tank *C* having a sloping bottom *D*, which deflects the heavier impurities to the front of the machine. The tank has an extension *E* into which the surface liquid flows, carrying with it the lighter foreign substances. These are drawn off through the pipes *F* and *G*, the former having a sieve fitted at its upper end to prevent the loss of rubber fragments. The height of liquid in the tank is varied by a vertically sliding gate *H* with-

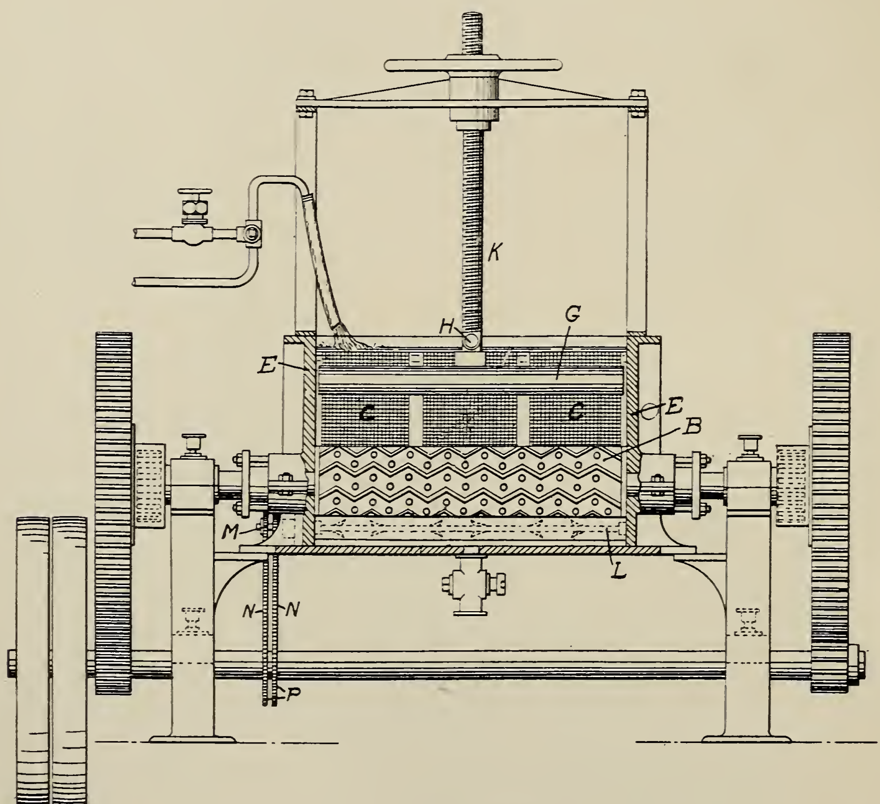


Fig. 11—The Dessau Washer.

in the extension *E,* this gate being regulated by the threaded hand wheels *K.* The charge of rubber is introduced between the rolls by the tilting hopper *L,* which is operated by the cable *M.* After passing through the rolls the rubber meets an inclined plane *N* which deflects the mass toward the front of the tank where it rises to the surface of the water. Here it is picked up by the revolving paddle wheel *P* and returned to the rolls. The washing liquid is supplied from the pipe *R,* into which steam and chemical solutions may be passed if desired. The liquid may be heated by the steam coil *S* lying on the bottom of the tank.

The Dessau Washer.

Another enclosed roll machine is the Dessau. It consists of a pair of rolls, corrugated and studded, revolving in a central screened box

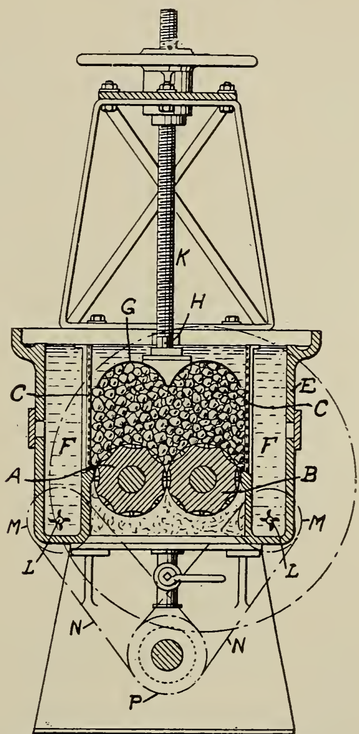


Fig. 12.—Sectional View of the Dessau Washer.

that is in turn enclosed in a tank. This gives a gathering space at the bottom and sides for foreign matter. The heavier foreign particles, if held in the washing liquid, may again be taken up by the rubber. One of the objects of the Dessau washer is to keep all impurities away from

the rubber and thus prevent them from being again mixed with it. For this purpose the double tank is provided, together with means for continuously agitating the liquid in the region where settling occurs.

The machine has two rollers *A* and *B* (see Figs. 11 and 12) located between screens *C* in the trough *E,* with an overflow space *F* in each side of the trough, into which water surges under action of the platen *G.* This platen is joined at *H* to the vertical screw *K* and rocks up and down. In the bottom of the spaces *F* are two spindles *L L,* provided with a series of agitator blades. They are driven by sprockets *M M,* chains *N N* and gears *P.*

The Kempter Washer.

Another enclosed washer is the Kempter, of German origin. This, like the Masticator washer, has bladed rolls set in curved troughs. The

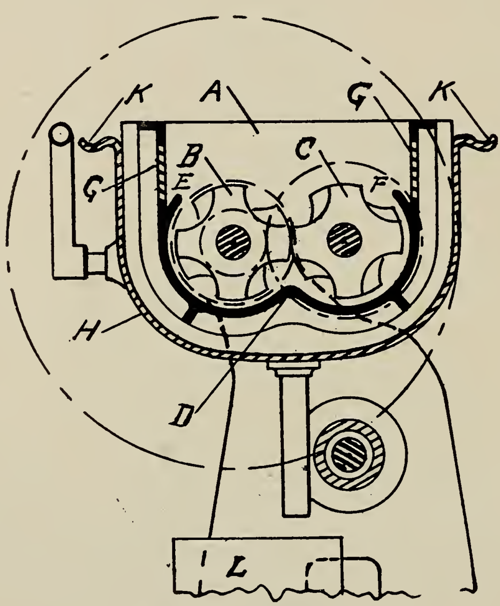


Fig. 13.—The Kempter Washer.

rubber passes down between the rolls, is opened up by a ledge between the troughs and then up between the rolls and the sides of the troughs. Foreign materials pass through perforations in the sides and over lips on either wall.

In this machine (Fig. 13.) means are provided for separating the heavier from the lighter foreign materials and for treating the waste

the second time to separate every particle of rubber therefrom. The mass of crude rubber or gutta percha to be treated is placed in the trough *A* containing two rolls *B* and *C*. These are formed with longitudinal projections which act as cutting or tearing edges. The bottom of the trough *A* has a center ridge *D*, giving it the form of two intersecting cylinders surrounding the rolls. When water is introduced and the machine started, the rubber is drawn down between the rolls. The roll corrugations and the ridge *D* tear the rubber apart and carry it up between the rolls and the sides of the trough *A*. The heavier foreign particles pass over the edges *E* and *F* and through gratings *G* into the surrounding tank *H*. The lighter impurities float to a channel *K*,

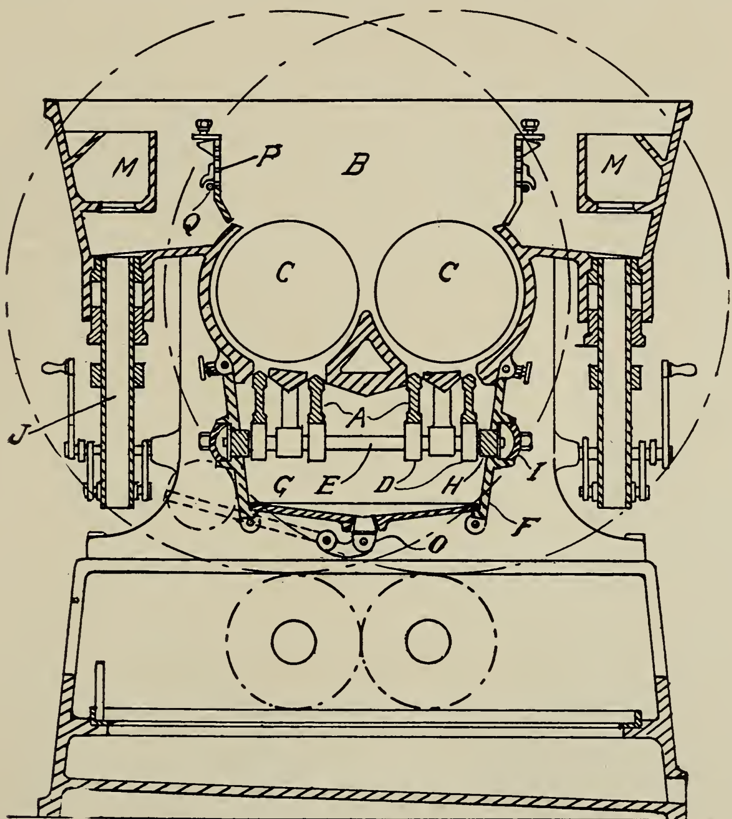


Fig. 14.—The Pointon Washer.

from which they may be floated off by raising the water level. The water and impurities are discharged into a tank *L* which is provided with screens, and the mass collecting thereon may be taken back to

the tank A for further treatment. When the rubber has been sufficiently washed, the trough A is emptied by rotating it about the shaft of the roller B.

The Pointon Washer.

Pointon's machine is notable in having adjustable closing devices, to regulate the area of the troughs beneath the rollers.

Fig. 14 shows it in transverse section, looking toward the ends of the rolls. The closing devices are plates A, each having its upper edge shaped to enter an aperture in the trough B, below the rolls C. The lower edge of each of these plates is provided with an eccentric D, whereby the plate may be raised or lowered. These eccentrics are mounted on shafts E which are carried at their ends in the hinged covers F of the sump G. The ends of the shafts are mounted in bearings H, and may be moved on removing the caps I, thus changing the position of the plates A.

The water level is regulated by vertically sliding pipes J, which co-operate with the subsidary weirs M through the opening in the bottom of each. When the pipe is in the position shown, water can enter the main trough through the upper end of the pipe. With the use of the weir a great increase in the height of the water level is obtained with a very small movement of the pipe, and in this way the employment of a sliding outlet gate is avoided.

The sump-like portion G below the trough has a sloping base, that the heavy impurities may escape through the center valve O.

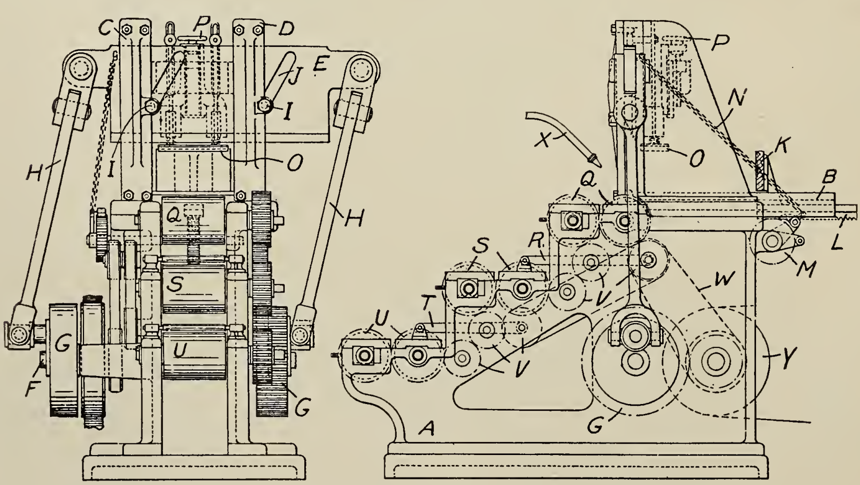


Fig. 15.—The Donnelly Slicing and Washing Machine.

The sides of this sump are hinged to drop down for cleaning purposes. At the top of the trough are adjustable perforated partitions or sieves *P* which are mounted on pins *Q* and on which they are rotated to open the main trough to the side weirs.

The Donnelly Slicing and Washing Machine.

Donnelly's machine slices crude rubber and sheets and washes it. In brief, it has a guillotine knife for cutting the rubber, two pairs of washing rolls and a pair of sheeting rolls. The drawings (Fig. 15) show a front and a side elevation of the machine. The bed *A* carries a table *B*, above which are secured two uprights *C* and *D*, forming guides for the knife *E*. A transverse shaft *F* carries two cranks *G* to which are attached the lower ends of the connecting rods *H*. The upper ends of these rods are pivoted to the outer ends of the knife *E*. The upright guides *C* and *D* carry two rollers *I* which work within diagonal slots *J* in the knife. On the table *B* is a feed board *K*, secured to the rack *L*. This rack is moved forward by the ratchet wheel *M* and the chain *N*, operated by each upward movement of the knife. Above the table is a presser bar *O*, which holds the rubber firmly in position. The carriage which bears this presser bar may be adjusted by means of the hand screw *P* to fit different sized lumps of rubber. The operation is as follows:

A lump of rubber is placed on the table and pushed forward under the knife. During the cutting a stream of water plays over the rubber from the pipe *X*. As each slice of rubber leaves the cutter it passes between the pair of grooved washing rolls *Q*, where it is squeezed and rolled to remove the impurities. It is then carried by the conveyor

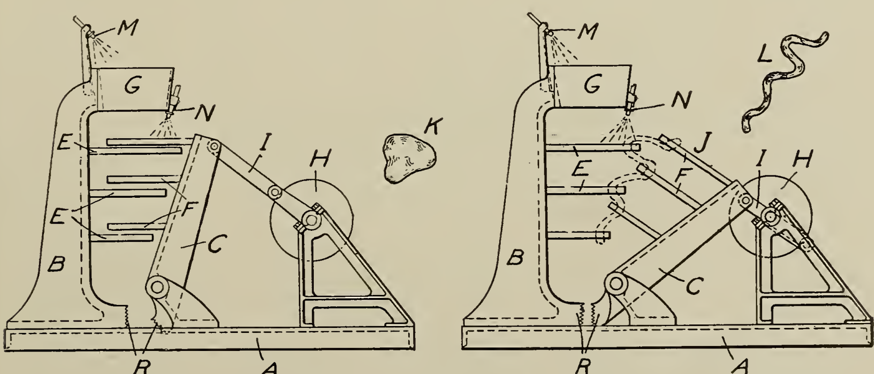


Fig. 16.—The Smith Washer.

R to the second pair of rolls *S*, where it is again rolled and pressed. It is then carried on a second conveyor *T* to a third pair of rollers *U*, which sheet it.

The Smith Washer.

Smith's machine, illustrated in Fig. 16, is of somewhat unusual construction. Upon the bed plate *A* are mounted two frames *B* and *C*. One is rigidly attached, while the other is pivoted at its lower end. Each of these frames has a series of jaws *E* and *F* extending toward each other. These jaws are U-shaped and are provided with teeth. When the frames *B* and *C* are at their minimum distance apart, as shown in the drawing on the left, the toothed portions of the jaws *E* and *F* form opposite sides of an almost circular passage through

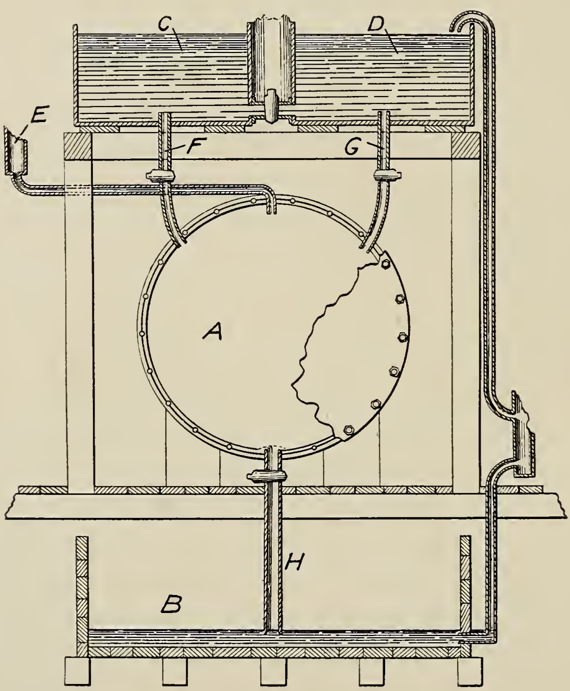


Fig. 17.—The Day Washing Machine.

which the rubber descends from a hopper *G* in the upper part of the frame *B*. When the frame *C* is set in motion, by power applied to the pulley *H* and communicated to the frame through the connecting rod *I*, the jaws *F* are forced back as indicated at *J*, so that a lump of rubber of the shape shown at *K* will be stretched into a thin

and corrugated sheet as indicated at *L*. As the crank shaft continues to revolve, the rubber sheet becomes thinner as it descends between the jaws. During this operation water is forced against the rubber from nozzles *M* and *N*. At the lower ends of the frames *B* and *C* are corrugated jaws *R*, which are opened and closed by the movement of the frame *C* and crush the rubber after it has passed through the stretching jaws *E* and *F*. The action of the machine tears the rubber so as to free the foreign matter, which is then washed away by the water.

Early Washers.

Some of the earlier machines, while not in use to-day, may have a suggestive value. Austin G. Day, the inventor of Kerite, very early produced a washing machine. The novelty lay chiefly in the use of chemicals and a vacuum process. His system was substantially as follows:

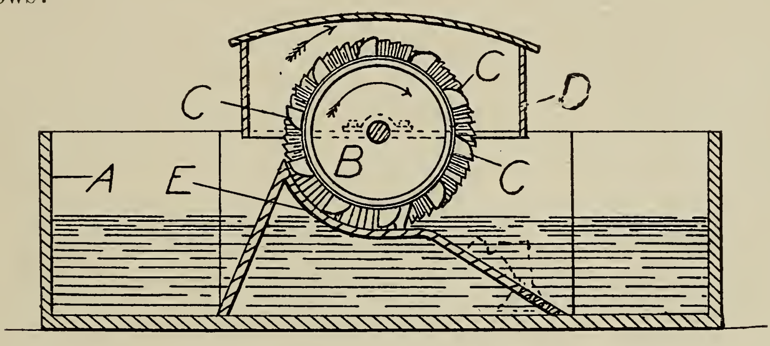


Fig. 18.—The Sault Washer.

The crude rubber was first cut into small pieces and worked in water to remove the largest particles of foreign matter such as wood, bark, dirt, etc. Then the water was drained off and the rubber placed in an air-tight cylinder *A*, (Fig. 17), above which were two small tanks *C* and *D* open to the air. These were filled with a strong solution of caustic soda which was pumped from a larger storage tank *B* where the solution was mixed. Connected with the air-tight tank were four pipes, two *F* and *G*, leading to the soda vats, one *E* to an air pump and the fourth *H* to the storage tank.

After the rubber was placed in the cylinder and tightly sealed a partial vacuum was created by the air pump, thus exhausting the air from the interstices of the rubber. Then the caustic soda solution was admitted into the cylinder, its flow being rendered easy on account of the vacuum. On coming in contact with the wood and bark the solu-

tion served to increase their specific gravity while it has no effect on the rubber. When the liquid had remained a sufficient length of time, it was drawn off into the storage tank, after which the rubber was removed and thrown into tanks containing water. The whole mass was thoroughly stirred, the wood and bark sank to the bottom while the rubber was left floating on the surface.

In the Sault process, Fig. 18, the rubber is first cut into small pieces and placed in the tank *A*. Then a stream of water is allowed to flow over the rubber at the same time that it is subjected to the action of the cylinder *B* which is provided with a set of teeth *C*. These teeth pass between stationary serrated bars as the cylinder *B* revolves, by which action the rubber is separated from impurities such as bark, etc. These sink to the bottom of the tank below the screen *E*.

In addition to the foregoing there are sundry individual machines and processes of minor importance in use in various factories for the further cleansing and treatment of crude rubber.

For example: In the production of a certain grade of rubber great difficulty was found in getting rid of the great amount of woody fibre that was present. After the rubber had been shredded both rubber and wood floated on the surface of the water, and if put through ordinary roll washers much fibre was imbedded in the rubber. One solution of the problem was a method of dissolving the wood fibre by treating the mass with a strong alkaline solution. After many experiments a simple process for removing most of it mechanically was invented. It was this: to float the shredded rubber and fibre into a tank that could be hermetically sealed. Air was then forced in and the pressure freed the minute globules of air that clustered about each shred of fibre, and the shred, water-logged, sank to the bottom out of the way.

The above covers pretty fully rubber washing where water alone is used. Where rubber is washed free from resins, for example, and solvents are used, a radically different apparatus is necessary. That, however, is another story.

CHAPTER II.

CRUDE RUBBER DRYING.

IT is only recently that the drying of crude rubber has been done with any regard to economy and efficiency. For years rubber in thick sheets hung in open rooms and dried and "aged" as best it might. If after many failures certain types were too weak to hang and proved to be so by dropping in sticky heaps on splintery floors, such rubber was reluctantly spread upon shelves. Then came the partial heating of the dry room by steam pipes; then ventilators to allow the moisture-filled air to get out, and then the fan, the fan blower and the vacuum dryer.

There are four systems possible: air drying without artificial heat, the heated air current, the vacuum system, and what is called the dessication system, that is, utilizing hygroscopic materials such as calcium chloride. Of these there are but two that are considered practical—the heated air current, and the vacuum system. In the first, the drying room is fitted with steam pipes, usually placed about the side walls. The heat is generally given off from steam circulating through such pipes. Excellent results, however, have been obtained from heavy oils that were first heated and then pumped slowly through the pipes. Drying rooms of this type necessarily take up much space, and to be effective should be constructed so that once the air is saturated it should be automatically removed by fan or blower, and then fresh, comparatively dry air introduced. An ideal adjunct to this system would be a preliminary drying of the air, either by chilling it or passing it over some hygroscopic material, then heating it and passing it into the rubber drying room. Esch, in his valuable hand book, describes an air current apparatus known as the channel dryer,* which will be described later.

The vacuum dryer, first brought to the attention of the rubber trade in Europe by Passburg, and successfully introduced into America by J. P. Devine, has become almost indispensable in modern plants. So necessary is it that a dozen or more machine builders are now supplying vacuum dryers of their own. Mr. Devine's own claims for vacuum dried rubber are worth noting.† He says:

* "Handbook for India Rubber Engineers," by Dr. Werner Esch, Hamburg, 1912.

† "Problems in Vacuum Drying," by J. P. Devine, India Rubber World, July, 1913.

"Until the introduction of the vacuum drying apparatus very primitive methods were employed, and occasionally an advocate is still found, who asserts that the hot air method is necessary for the proper curing of some particular grade of rubber. The fallacy of such assertions is proved by the use of the vacuum apparatus in drying every grade of crude rubber.

"While it is true, considerable thought was given to improving processes for drying rubber, there were no striking departures from the antiquated method of using hot air as the heating medium. The dust and dirt that would settle upon the rubber were the least of the evils; the construction of special drying rooms from which direct sunlight was excluded, and provisions to eliminate dust and dirt, and the regulation of temperatures for various grades of rubber, as well as the attempt to dry the air before being admitted into the drying room, all contributed to avoid the deterioration of the rubber by such means; but the value of these improvements was doubtful as they only tended to reduce the effect of high temperatures with a consequent prolongation of the drying period. The fact is that the two insidious enemies of rubber are heat and oxygen and these elements are, and always will be present, and necessarily so, in any system of hot air drying. They are deteriorating agents and their elimination is most essential for the proper drying of rubber. Their elimination by the vacuum apparatus has proven the superiority of the vacuum-dried rubber in the processes of its manufacture.

"Another and serious objection to the hot air system of drying rubber is, that rubber as it comes from the washing machine, contains a very large proportion of mechanically bound moisture. While this is readily given off in the hot air drying room, its expulsion causes a contraction of the rubber, which, with the oxidation constantly taking place, causes a hardening of the surface that prevents the elimination of the last moisture within the rubber, except by a very prolonged drying period, during which time the rubber is further subjected to oxidation and not unlikely to excessive heat. Unless the last traces of moisture are eliminated, "blowing" is sure to result during the following stages of its manufacture.

"We still hear occasionally about 'ageing' rubber; but in reality this is simply the removal of the final traces of moisture; as stated, under atmospheric conditions, this can only be accomplished by a prolonged drying period, while under vacuum the rubber is thoroughly dried in a very short time, and in practice rubber is immediately worked up after removal from the vacuum dryer.

"The deteriorating agents—oxygen and excessive heat—can be eliminated only by the vacuum process and apparatus. This process and apparatus alone afford the proper conditions to dry rubber rapidly, uniformly and thoroughly at a low temperature and without oxidation, independent of climatic conditions.

"It must be borne in mind that under atmospheric conditions a rapid boiling can only take place at 100 degs. C. or 212 degs. F., and that as the temperature decreases, the drying time is extended; while under the vacuum the boiling point is greatly decreased and increasingly so as the barometric reading is approached. To illustrate, under

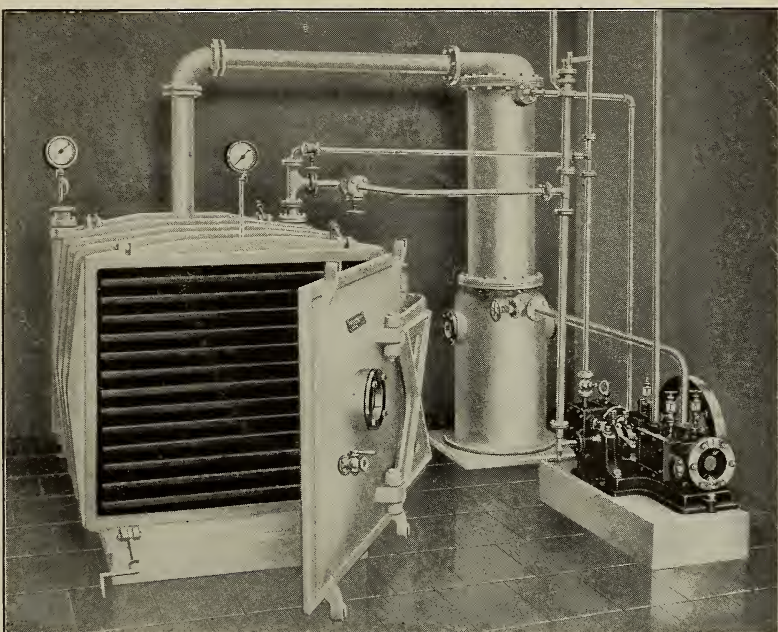


Fig. 19.—Vacuum Shelf Dryer, Condenser and Pump.

a vacuum of 29 inches water boils at 25 degs. C. or 77 degs. F. Rubber dried in the vacuum chamber, while the first free water is being removed, will not need to be heated, practically, above the boiling point of water at that particular vacuum. As the moisture is evaporated from the rubber, naturally the temperature of the rubber being dried tends to increase; to prevent any overheating the supply of the heating medium—steam or hot water—is regulated accordingly and entirely shut off before the final drying; the last traces of moisture are therefore drawn off by the latent heat in the dryer accelerated by the high

vacuum. Because seemingly high temperatures are used at the beginning of the drying process to expedite evaporation, the erroneous impression is sometimes formed that the rubber is overheated in the vacuum chamber; but in a properly constructed vacuum chamber with its auxiliaries—condenser and pump—properly balanced, the application of well-known physical laws absolutely prevents any overheating if only reasonable care is taken in its operation.

"In an average establishment of today, making a general line of rubber goods, two tons of crude rubber is a conservative estimate of its consumption. If the old hot-air method is used, in order to properly and thoroughly dry the washed and sheeted rubber, six weeks are consumed in the drying process. Seventy-two tons of rubber would be hanging in the drying lofts, which at 75 cents per pound, would represent an idle investment of $108,000 on raw material, the carrying charge of 5 per cent. amounting to upward of $15 per day; and should the carrying charges for instance, factory space, etc., be included, the above sum would be greatly increased.

"The same quantity of rubber could be more thoroughly and permanently dried by one or two vacuum chambers in a day of ten hours, so as to "work up" whatever grade may be required for each day's output, and the initial cost of such an installation would be less than the cost of the old-fashioned drying rooms for the same quantity. So that the vacuum chamber pays for itself in the savings on investment, carrying, insurance and other fixed charges on raw material, as well as gives a flexibility to the factory for its daily production that cannot be obtained by any hot-air method.

"To illustrate the great saving in factory space, a vacuum drying chamber having a capacity of approximately two tons of dry sheeted rubber per 10 hours, occupies a space of 8½ feet high, 15 feet wide by 9 feet long; and its auxiliaries, the condenser and the pump, can be conveniently located at any place in the factory in proximity to the dryer.

"In cases, however, where complaints have arisen, the well-meaning people who were using such a dryer, being surprised at the capacity of the apparatus far exceeding their expectations, thought it right to go still further by greatly increasing the charge of rubber and ultimately loading the apparatus with a much larger quantity than their apparatus was intended for. Of course, it was soon found that the increased charge could not be dried in the stated time, nor with the stated temperature of heating steam. As it is only human not to decrease one's desires, the natural human remedy was resorted to, that is, an increased

temperature of heating steam and also a prolonged drying time. If you consider that the heating surface at a certain temperature within the dryer is intended for a layer of rubber of a uniform and certain thickness, its capacity, or rather the beneficial results obtained therefrom, will be destroyed, or at least impaired, by an increased quantity of rubber per charge and an increased temperature of heating steam, because the heating surface itself remains the same; and it is this factor which remains constant—that upsets the results sought to be obtained by the violation of well known, but not considered, natural laws.

"Experience has taught us to balance the necessary heating surface, to transmit a certain temperature to a certain layer of material to be dried; and it is quite erroneous to argue—though a common mistake—that the same beneficial results may be obtained from a larger quantity of material, by simply increasing the thickness of the drying material and increasing temperature, in the belief that the above mentioned factor would increase proportionately. This, however, is not the case, as I will more fully point out.

"If one takes the conductivity of rubber alone into consideration, and the gradual but decreasing evaporation of the water contained therein, it can very easily be understood that by altering some of the factors the physical laws, on which our calculations are based, will be violated without any such intention, and the penalty will be an unsatisfactorily dried rubber;—the cause of which is naturally placed at the wrong door. The fault is not in the apparatus, but in the method of its operation. The same remarks refer to the auxiliaries of an apparatus for drying rubber. These auxiliaries consist of a condenser and vacuum pump which are both calculated to correspond with the capacity of the vacuum apparatus they are intended to serve.

"To illustrate what I mean: A vacuum dryer of a certain drying capacity and calculated for a certain purpose is intended to evaporate a certain quantity of water in a given time, and of course, which is essential, at as high a vacuum as is possible under practical working conditions. All this is, to a great extent, based on practical experience with the very material our apparatus is used for. If, however, the condenser, instead of handling the quantity of vapor for which its cooling capacity is calculated, is burdened with ever so much larger a quantity, the result must be detrimental in two ways: it not only re-acts on the dryer and the product it is supposed to turn out regardless of the time, but also re-acts on the working of the pump.

"As regards the vacuum dryer, it is essential to have its inner space continuously freed from the vapor arising from the drying mate-

rial in order that no inner pressure may be created in such apparatus to lower the vacuum. This can only be done by having the arising vapors taken care of in their entirety during their passage through the condenser, the capacity of which cannot be changed at will.

"If more vapors are created than the condenser is intended for, such vapors will partly remain in the dryer, and create inner pressure. The inner pressure thus created consequently reduces the vacuum in the dryer and as a consequence the boiling point of the water contained in the rubber is increased, and the rubber will be heated up to a tempera-

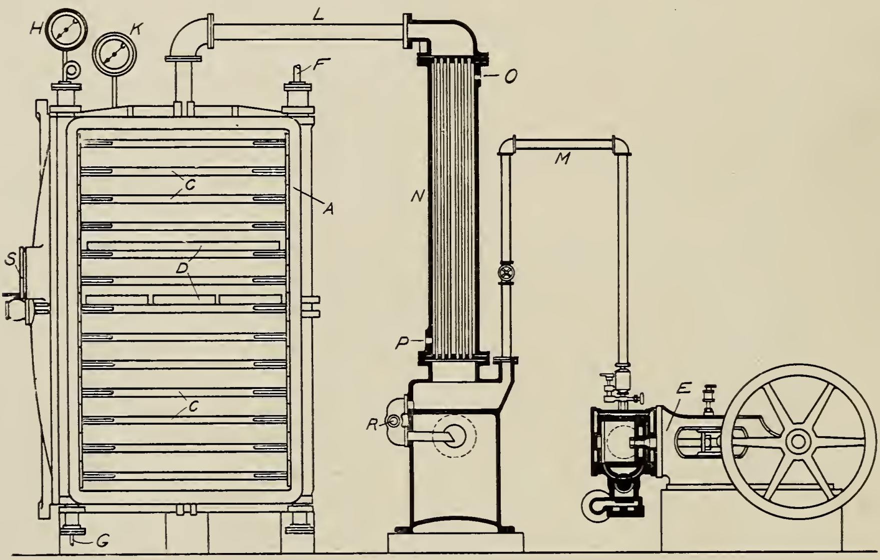


FIG. 20.—VACUUM SHELF DRYER.

ture never intended, with detrimental effects to its quality. The overcharging, as I said before, affects the efficiency of the pump and prevents it from creating the desired high vacuum. The reason for this is that a dry vacuum pump—the only type we have in mind in this discussion—is intended, dimensioned and constructed for pumping air and not vapor, particularly as the latter expands so enormously under vacuum. If the pump were intended to exhaust rarified or expanded vapor in addition to rarified or expanded air, its dimensions would be so enormous as to make its use practically impossible.

"If, therefore, the dry vacuum pump has to exhaust vapors which have passed uncondensed through the over-taxed condenser, a burden is placed on the pump for which it was never intended; its work becomes

inefficient and most naturally impairs the vacuum and efficiency of the whole installation for drying purposes."

On the other hand, authorities like Dr. Werner Esch and Adolph Heil claim that while air drying may bring about slight oxidation it never results in depolymerization from heating. Vacuum drying, however, often results in quite an appreciable depolymerization.*

Where the rubber will not sheet and is in the form of scrap, a centrifugal dryer is sometimes employed, but the rotary type of vacuum dryer used in drying reclaimed rubber is to be perferred. Vacuum masticators are also used to an extent in crude rubber drying.

Vacuum Dryers.

Fig. 20 shows the Devine vacuum chamber equipped with condenser and vacuum pump. The dryer consists of a cast iron chamber A which contains a number of steam-chambered shelves C placed one above

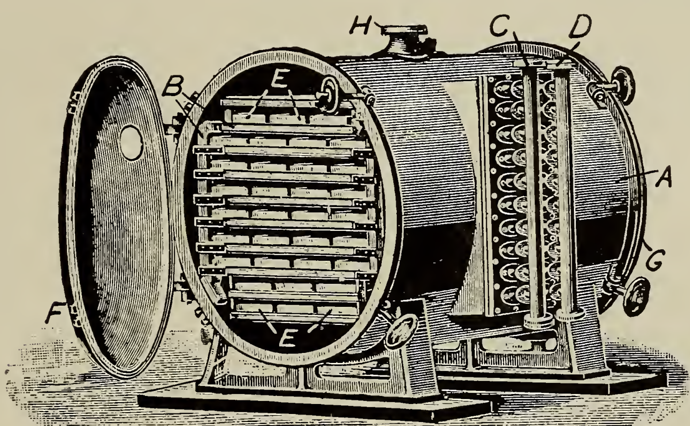


Fig. 21.—Cylinder Vacuum Shelf Dryer.

the other. The rubber is placed on the shelves or it may be placed in the metal trays D. The shelves are strong enough to withstand a pressure of 100 pounds per square inch. The vacuum is created by the air pump E while steam passes through the inlet F, into the hollow shelves and out through the pipe G. The temperature is regulated by valves in the steam pipes, the pressure being recorded by the steam gage H. A vacuum gage K is attached to the top of the dryer. Between the vacuum pipes L and M is a condenser N, to condense the vapor from the rubber. The condenser cylinder is filled with brass

* "Handbuch der Gummiwaarenfabrication," by Adolph Heil and Dr. Werner Esch, Hamburg.

tubes around which cold water is circulated, passing into the condenser at P and out at O. It has an observation glass so placed that the amount of condensation may be noted. The receiver can be drained without retarding or interfering with the drying, by a by-pass R. The doors are provided with observation glasses S through which the condition of the rubber may be observed.

In Fig. 21 is shown a simple form of horizontal cylinder vacuum dryer. The cylinder A contains a series of hollow iron shelves B connected with multiple steam inlets C and outlets D. These are attached to a removable plate on the side of the cylinder so that the steam passes directly into each shelf. The rubber is placed in trays E on the shelves and the doors F and G are closed, after which the air is exhausted by a pump attached to a pipe leading from the connection H.

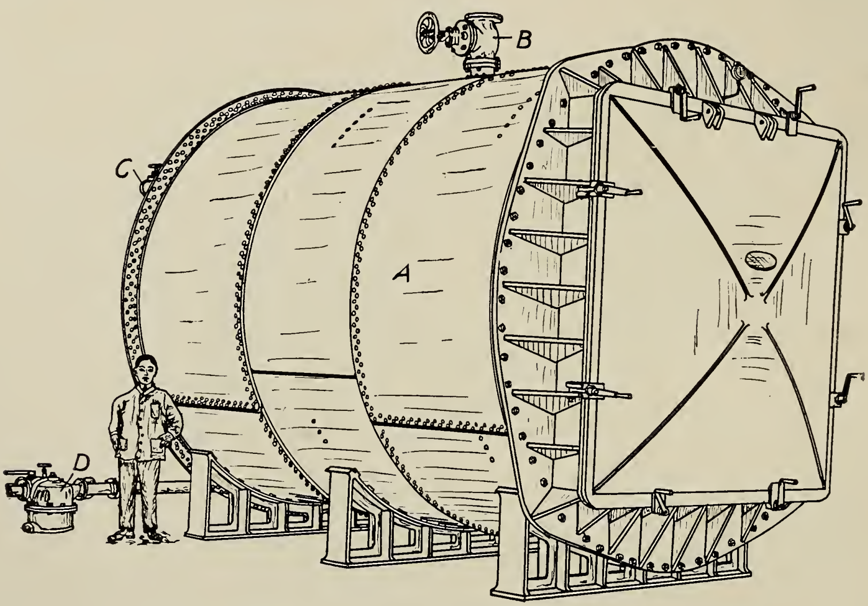


Fig. 22.—Vacuum Dryer.—German.

Reference to Fig. 22 will serve to give an idea of the enormous size of some vacuum dryers. This illustration shows a German type about 15 feet high and 20 feet long. It does not, however, differ in principle from the other vacuum dryers. The cylinder A is provided with a connection B at the top for attaching the vacuum pump. The steam enters at C and passes out at the lower side into the steam trap D.

The Channel Dryer.

In Fig. 23 is shown the Channel Dryer. This is a dry room fitted with an overhead mechanism that carries the sheeted rubber from one end to the other. Dry, hot air is forced through the room in the opposite direction to which the rubber travels. Thus the dryest rubber comes in contact with the dryest air. After the dryer is loaded, the doors are closed and the hot air forced through by fans. When the

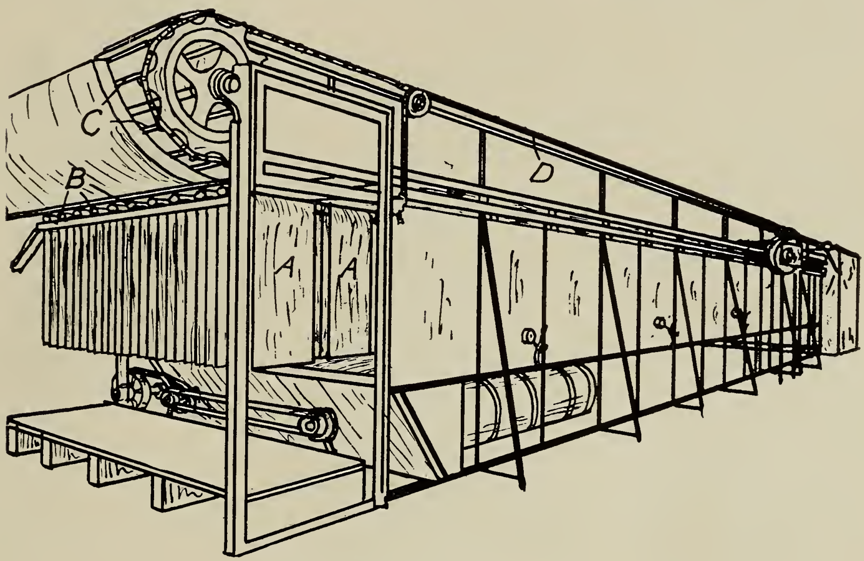


Fig. 23.—The Channel Dryer.

sheets of rubber that hang at the end through which the hot air enters, are dry, the doors are opened and those sheets removed. The rest of the partially dried rubber is then moved forward. This leaves room for a fresh supply of wet rubber at the other end. It will thus be seen that the traveling chains only move when loading and unloading. In the illustration, *A* shows the sheets of rubber hung over a wooden grill *B*. The grills, with their load of rubber, are attached to the crossbars *C* which, in turn, are fastened to the endless chains *D*.

The Sturtevant Dryer.

Fig. 24 shows the Sturtevant dryer for crude rubber which will not hang on cross rods. The drawing shows a partial cross section through the drying rooms with a blower *D,* attached to the lower compartment. The rubber is carried to the upper floor *A* either by a conveyor or in crates, and spread out and left until partly dry. It is then dropped

through the opening *B,* falling on the floor *C,* where the drying process is completed. This dryer may have walls and roof of any ordinary material, but the floors are made of expanded metal or perforated iron

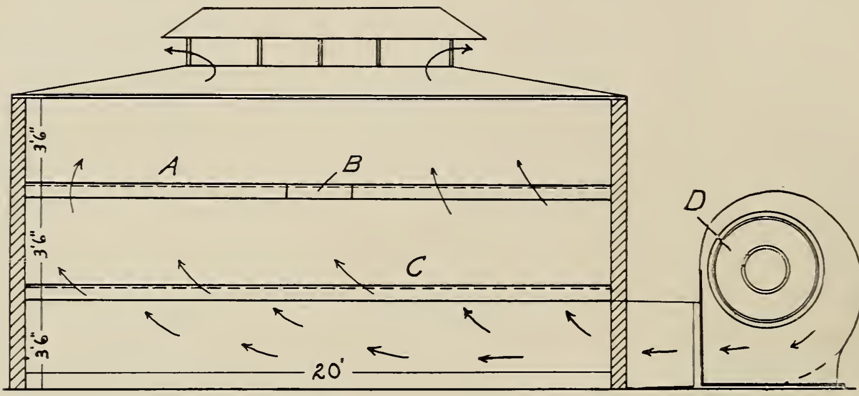


Fig. 24.—The Sturtevant Dryer.

plates, through which hot air is blown. In erecting a building for this work it is usually estimated that one cubic foot of air will absorb two grains of moisture, and that about 50 per cent. of the air should be re-circulated.

The "Dryventor."

The "Dryventor," shown in Fig. 25, is a type of dryer which has been used for years for extracting moisture from fruits, but which

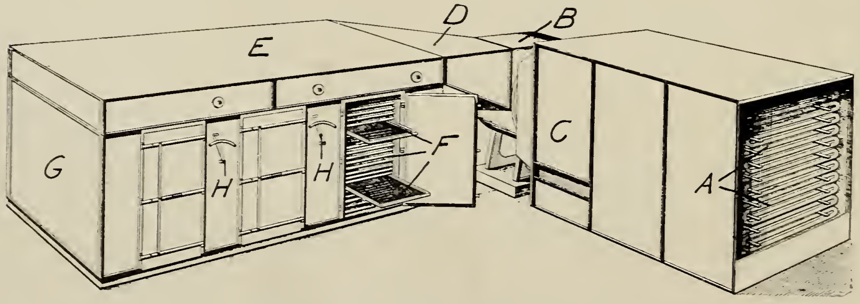


Fig. 25.—The "Dryventor."

has been adapted with slight alterations, for drying rubber. The process consists essentially in subjecting the rubber to moving currents of dehydrated air, having a temperature sufficient to effect rapid extraction of the contained water, but not to injure the rubber.

Referring to the illustration, there is a series of refrigerating coils *A,* over which air is drawn, through a screen, by a suction fan enclosed in the casing *B.* In passing over these coils the moisture in the air is condensed and precipitated. This dehydrated air is then heated by passing it over a series of steam coils, located in the end of

Fig. 26.—Fan. Motor Driven.

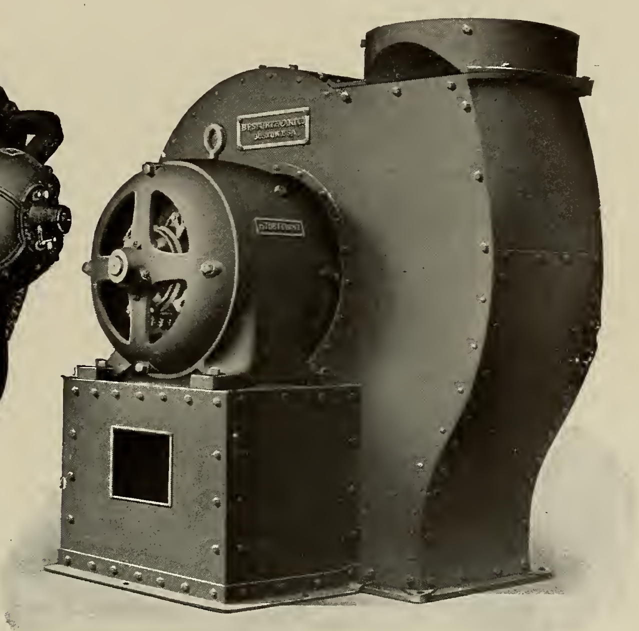


Fig. 27.—The Sturtevant Blower.

the air chamber at *C.* It is then blown through the passage *D* and against a series of baffleplates in a casing *E.* These plates deflect it downward over the rubber, which is spread on the screens *F.* The air passes out of the chamber *G* through a passage at the bottom. The drying room is divided into compartments, and the warm air may be sent through one or all of these by regulating the dampers controlled by the handles *H.*

Vacuum Pumps.

The efficiency of the vacuum drying apparatus depends largely upon the pump used to maintain the vacuum. Rapid evaporation at a low temperature necessitates the maintenance of a high vacuum. The pump shown in Fig. 28 is a good example of the horizontal type. It

is of the double-acting, steam driven, rotary valve type in which the steam engine and vacuum pump are direct connected and built with an integral frame.

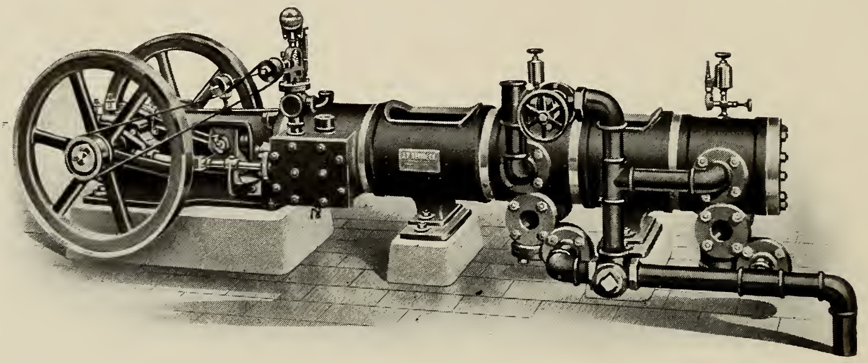


Fig. 28.—Steam Driven Vacuum Pump.

Fig. 29 shows another two-cylinder horizontal vacuum pump, of the two stage, motor driven type. This pump has an electric motor attached directly to the bed of the pump and drives the large gear on

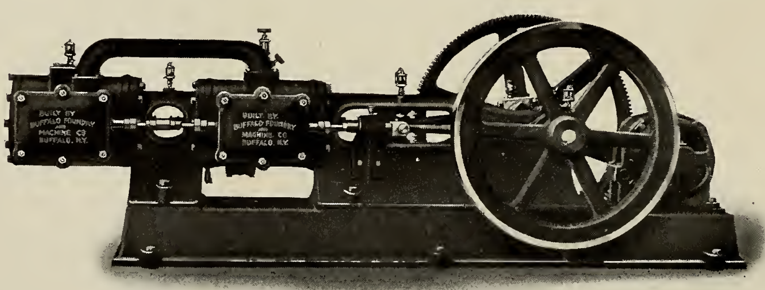


Fig. 29.—Motor Driven Vacuum Pump.

the pump shaft through a pinion on the motor shaft. The air valves are self-seating without springs and have a by-pass for rarifying the air left in the clearance space at the end of the stroke.

Condensers.

The condenser is used to reduce vapors to liquids. Fig. 30 shows one form of surface condenser in which the condenser *A* and

receiver B are combined in one. The vapor passes from the vacuum chamber into the condenser at C and through a series of metal tubes D which are surrounded by cold water which enters at E and passes out at F. On striking the cold tubes the vapor is condensed and flows into the receiver as water. By the by-pass G, the water is drained off. The pipe leading to the vacuum pump is attached to the condenser at H. This device is shown connected with a pump and vacuum dryer in Fig. 20.

Fig. 31 shows a cascade injection condenser. By means of a series of shallow adjustable trays A, the cooling water, which enters the con-

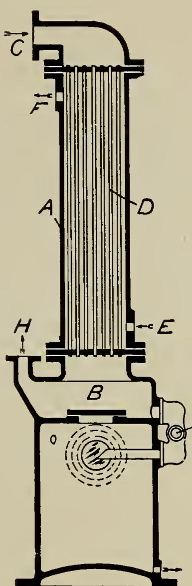


Fig. 30.—Surface Condenser.

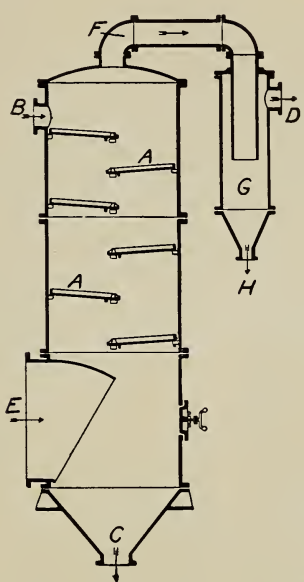


Fig. 31.—Injection Condenser.

denser at B and leaves at the lower end C, flows in thin sheets, falling from one tray to another. This exposes the vapor to a large cooling surface, resulting in quick condensation. The vacuum pump is attached to the pipe D and draws the moisture from the vacuum dryer through the connection at E. Most of the vapor is condensed by the cascades of water falling from the trays, but any which escapes passes up into F and is condensed in the cylinder G, and drained off at H. This type of condenser is used where large quantities of vapor are to be handled.

Percentages of Moisture in Rubber.

In this connection it is interesting to know, at least approximately, how much moisture the hot air current or the vacuum dryer extracts from crude rubber. The percentages in the table of shrinkages that follow include water and foreign materials; it is the former, however, that is responsible for most of the loss in weight.*

Percentage Loss of Weight in Drying.

	Pearson.	Clouth.
American.		
Para fine	15 to 20	18 to 20
Para Negroheads		40
Para Matto Grosso		28
Mangabeira	20 to 35	40 to 42
Brazil sheets		33
Caucho	20 to 40	37 to 42
Mollendo		14
Cameta		37 to 42
Peruvian scraps		25
Santos		28
Central America	20 to 40	
African		
Tongues (no specific origin)	18 to 25	
Flakes " " "	25 to 35	
Thimbles " " "	15 to 35	
Accra	20 to 40	
Bissao		35 to 43
Gambia		30
Rio Nounez		35
Conakry		36
Calabar lumps		36
Casamance		52
Leone Niggers		35
Bassam		30 to 36
Cape Coast, Salt Pond, Addah, Quittah, Axim:—		
Buttons	20 to 30	40
Biscuits	20 to 30	35 to 42
Flakes	30 to 35	48
Lumps	30 to 40	

* "Rubber, Gutta Percha and Balata," by Franz Clouth and B. F. Voigt, Leipzig, 1899; and "Crude Rubber and Compounding Ingredients," by Henry C. Pearson, New York, 1909.

African—(Continued.)

	Pearson.	Clouth.
Niggers	20 to 35	48
Lagos buttons	25 to 35	
Lagos lumps	30 to 40	37 to 45
Lagos strips	25 to 35	
Cameroon balls	18 to 25	35 to 43
Cameroon clusters	18 to 28	35 to 43
Congo buttons	25 to 30	23
Congo balls	20 to 35	23
Upper Congo	20 to 25	12 to 18
Upper Congo, red balls	18 to 22	
Upper Congo, Lopori	16 to 22	
Kassai black twists	18 to 22	18 to 30
Kassai red twists	20 to 25	18 to 30
Kassai ball twists	20 to 25	18 to 30
Benguela and Loando sausage	16 to 20	15 to 24
Benguela and Loando niggers	18 to 20	18 to 25
Mozambique	10 to 35	15 to 35
Madagascar	25 to 55	40
Madagascar pinky	30 to 35	
Majunga black	30 to 40	35 to 38
Majunga niggers	30 to 40	
Asiatic.		
Assam	8 to 45	31
Assam No. 1	10 to 15	
Assam No. 2	20 to 30	
Assam No. 3	30 to 35	
Penang No. 1	10 to 15	30
Java No. 1	10 to 15	13 to 23
Borneo	30 to 45	20 to 55
Rangoon		45
Chinde		11

CHAPTER III.

DRY-SIFTING AND BATCHING OF COMPOUNDING INGREDIENTS.

THE scores of metallic oxides, sulphides and earthy ingredients that are used in rubber compounding must be dry, fine and clean. As they are often bought in bulk this necessitates special receptacles and machines for their storage and treatment before they are ready for the mixing mill. Every factory, therefore, has its compound room for weighing out batches. An adjunct is the storage room where the ingredients are prepared for weighing. For drying earthy materials bins are employed that may be heated and in which are stirrers. Materials that have a tendency to absorb moisture are kept in zinc-lined bins fitted with tight covers. Formerly all of the dry ingredients were weighed out in quantity, mixed together and run through burr stone mixers. Then a certain portion of this agglomeration was weighed out to go with so much rubber for a batch.

Today, however, all of the ingredients are handled and weighed separately. After drying and sifting they are ready for the compound room. Indeed, in some plants they are delivered there by automatic machines from the sifters. Sometimes the room for preparing the ingredients is located directly above the compound room and small chutes are put in to carry the materials down. Such chutes must be fitted with stirrers, for if gravity alone is depended upon the materials choke and stick fast.

The compounding room is built to accommodate the kind of work the factory produces. It is usually fitted with many large pigeon holes for massed rubber of various sorts, reclaimed rubber, etc. The sulphur, whiting and like ingredients are in bins and rarely in the original package. Oils are kept in small tanks from which the necessary quantities can be readily pumped. In some factories ordinary scales are used for the weighing. In others, scales that have arbitrary signs and unusually shaped weights, are used for the purpose of secrecy. For the same purpose the ingredients are often given false names and the compound cards are made up in cipher.

Many of the best sifting appliances are also designed to mix dry powders. In the present practice in rubber manufacture, this is rarely

done, the ingredients being kept separate during the drying and sifting, and assembled in the pans that go to the rubber mixer.

German Reciprocating Sifter.

Fig. 32 shows an exceedingly simple and practical sifter that could be built in almost any machine shop. One or more sieves are placed in the sieve box *A*, and shaken back and forth by the con-

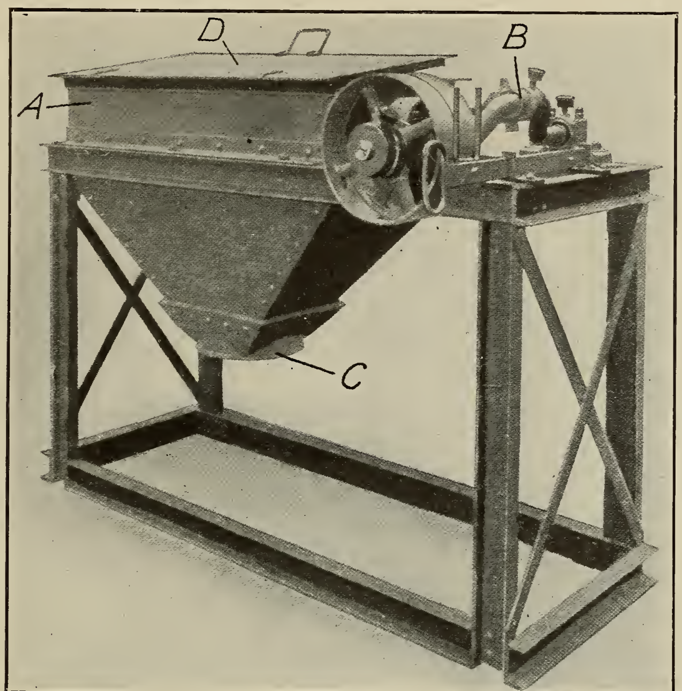


Fig. 32.—German Reciprocating Sifter.

necting rod attached to the crank *B*. *C* is the discharge and *D* being the hinged cover of the sieve box.

The Gauntt Sifter.

Fig. 33 shows the Gauntt sifter and mixer, a type of machine which is often used for sifting compounding ingredients. The material is placed in the hopper *A* and is agitated by the spiral brushes *B*, which sift it through the screen *C* into the mixing cylinder *D*. Foreign materials, strings, lumps, etc., are discharged from the sifter through the spout *E*. The mixer has two opposed spiral agitators *F* with a

number of blades *G* set at different angles to thoroughly agitate and blend the compounding materials by constantly reversing them and carrying them in different directions. The machine is driven from the belt pulley *H* on a countershaft, through a pair of spur gears *I* and *J*. The gear *J* is keyed to the shaft *K* of the mixing cylinder, while the sifter brush is revolved by the sprocket chain *L*. These machines are

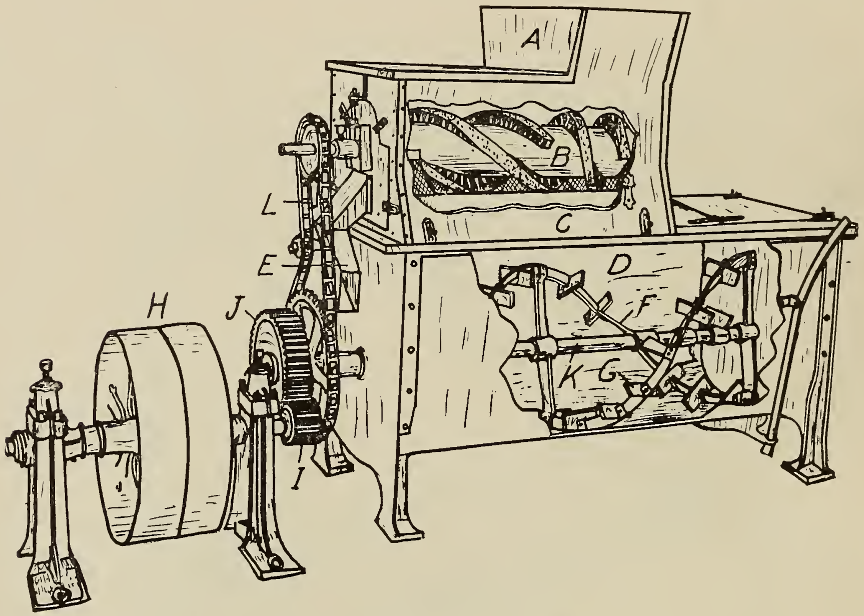


Fig. 33.—The Gauntt Sifter.

made in nearly a dozen different sizes, with capacities from 10 to 100 barrels per hour. A machine with a thirty barrel capacity occupies a space 8 x 2 x 5 feet.

The Gardner Sifter.

In Fig. 34 is shown two interior views of an English type of combined sifting and mixing machine. The feed hopper *A* is provided with a gate *M* which can be opened or closed for controlling the ingredients which pass from the hopper to the semi-cylindrical sieve *C*. The materials fall from the hopper into a helical brush *B* on the roller *N*. The brush forces the fine material through the sieve, while the lumps are carried along to the reducing portion of the brush *P*. This breaks up the lumps and passes them through the sieve *C*. Any foreign matter such as particles of stone or wood and irreducible lumps are automati-

cally thrown out through the spout *H* at the end of the sieve. The sifted materials fall into the mixing chamber *F* which contains an agitator mounted on the shaft *G*. After the materials are mixed the outlet *I* is opened and the contents discharged. Where there are no lumps in the materials and only a gentle sifting action is required, a different brush is used. The sieve can be quickly withdrawn as shown by the position

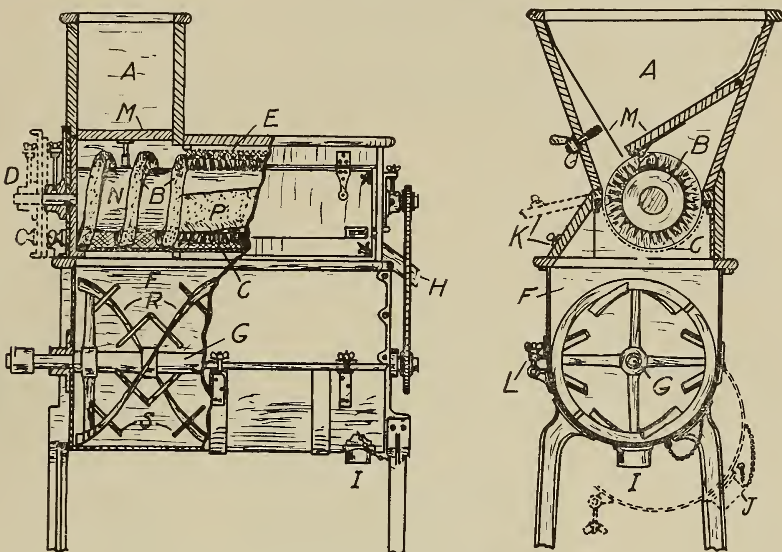


FIG. 34.—THE GARDNER SIFTER.

of the dotted lines at *D* and another sieve of coarser or finer mesh inserted in its place. The brush is also removable. By loosening the thumb screws *L* the bottom portion of the mixing chamber may be opened as shown by the dotted lines *J*, for cleaning the blades.

THE WERNER & PFLEIDERER SIFTER.

The apparatus shown in Fig. 35 is the Werner & Pfleiderer spiral brush sifter, which is very convenient where small quantities of compounding ingredients are to be handled. The machine consists of a wooden box *A* in which revolves a spiral brush *B* fitting into a semi-cylindrical sieve which forms the bottom of the trough-like receptacle. The material to be sifted is placed in a hopper above the box and conveyed along by the brush until all soft lumps are crushed. The fine material falls through the sieve while hard lumps and refuse are delivered through an outlet *C*. The pressure of the brush on the sieve may be adjusted by set screws at each end of the machine. Sieves of dif-

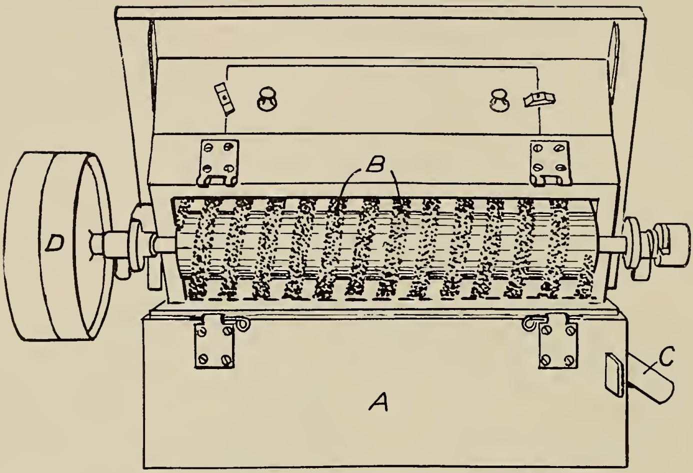


Fig. 35.—The Werner & Pfleiderer Sifter.

ferent mesh may be used for sifting materials of different degrees of fineness. This machine is driven by pulleys *D* as shown, or by a hand crank when it is used infrequently.

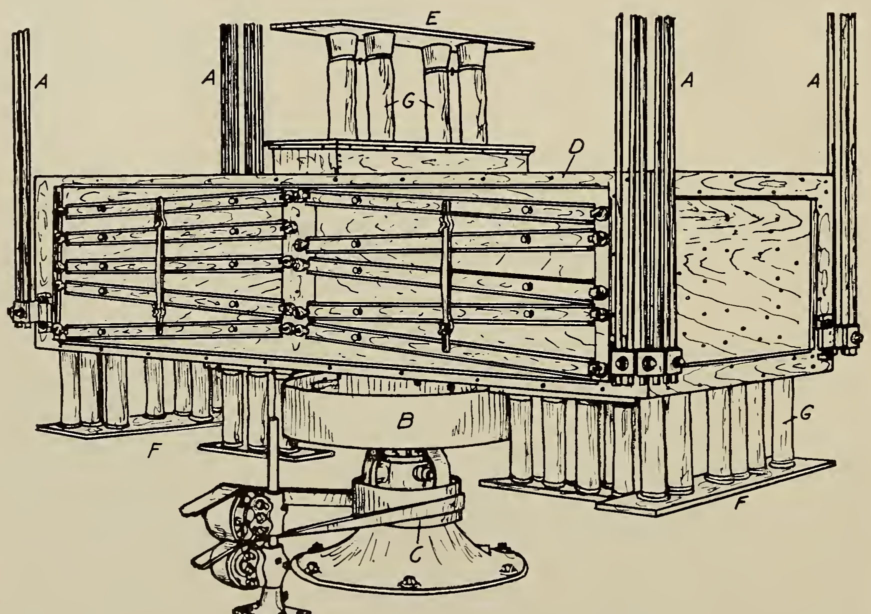


Fig. 36.—The Gyrator Sifter.

The Gyrator Sifter.

The illustration shown in Fig. 36 is a different type of sifter from any of the foregoing. The sieve box is suspended from the ceiling by wooden hangers *A* and the removable sieves are held in place by clamps. The sieve box *D* is given a combined reciprocating and gyratory motion by the eccentric fly wheel *B*, which is driven by the belt pulley *C*. Thus the materials to be sifted are kept in constant motion. The swing of the box is counterbalanced by weights in the flywheel and a perfect running balance is secured. The material is placed in a hopper at *E* and after passing through the sieves it falls through the cloth chutes *G* into receivers placed under *F*.

Automatic Measuring Machine.

In Fig. 37 is shown a German apparatus for measuring quantities of powdered material and delivering the batches through a discharge

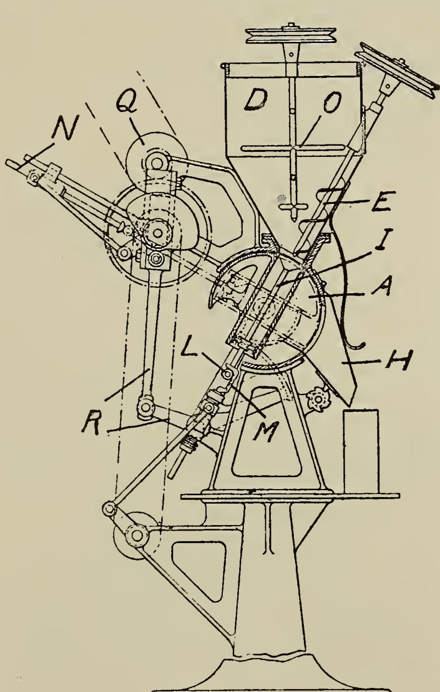


Fig. 37.—Automatic Measuring Machine.

chute. The material is stored in a hopper *D*. An agitator *O* keeps it from clogging. A spiral conveyor *E* delivers it to the measuring

cylinder A. In this is a conical piston with a sharp edge to further prevent clogging. This piston is drawn downwards by a roller L on the piston rod I by a pulling device M operated from the main shaft. The cylinder is oscillated by sectors rocked by a crank arm and link R, by engaging a cam rotated by gearing from the driving pulley Q. To discharge the batch the cylinder is turned until it is opposite the chute H. Then the rollers L worked by the discharge device N ejects the contents. The cylinder then automatically returns to the filling position.

Compounding Scales.

The old style beam scale is still used in many factories but it is not in the line of either accuracy or efficiency. The automatic scale, therefore, is fast displacing it. In weighing automatically the operator

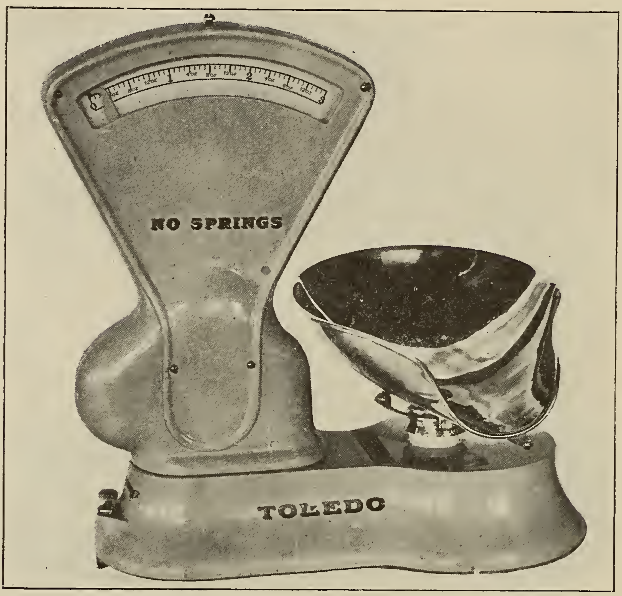


Fig. 38.—Small Automatic Scale.

merely reads the weight; the scale does the rest instantly. There are no loose weights, no calculating. Time and labor are saved, the cost of weighing cut and losses from wrong weights eliminated and disputes avoided.

In both the old and the new types platform and beam scales with pans are used. The most convenient is a 25-pound automatic scale. See Fig. 38. This is equipped with a 2 to 10 pound chart, graduated in ½ ounces. Where big batches are weighed out the same type

of scale is employed but with a larger capacity. The portable platform scale, Fig. 39, really comes in three styles, one for the shipping room, one for special use such as tire weighing, and for batch-

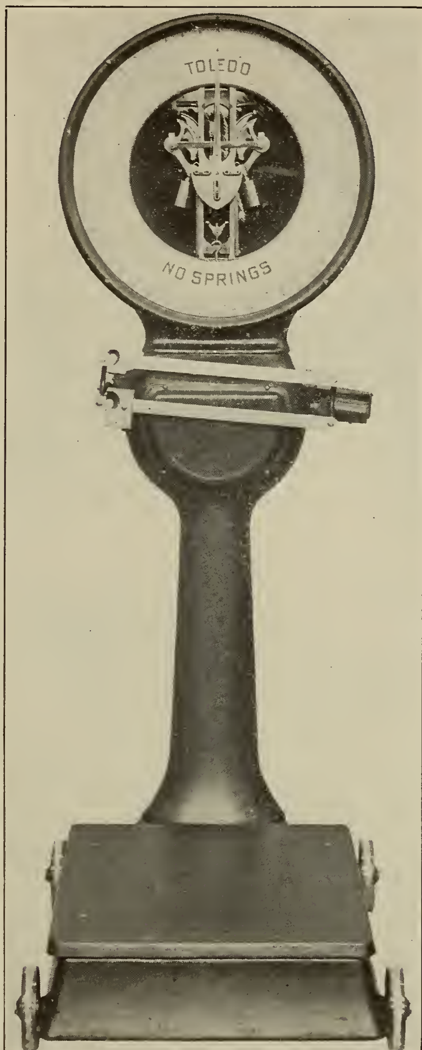


Fig. 39.—Portable Platform Scale.

ing in the compound room. In the illustration shown, it is provided with a tare beam, that is of value in the receiving department, or in recording the weight of pans or trucks.

The Ross Pulverizing Mill.

It is sometimes necessary to have a grinding apparatus for lumpy material. The mill, shown in Fig. 40, is a powerful machine of large capacity for grinding moderately hard substances such as flour of sulphur, dry colors, litharge, rosin, oxides of lead and zinc, whiting, etc.

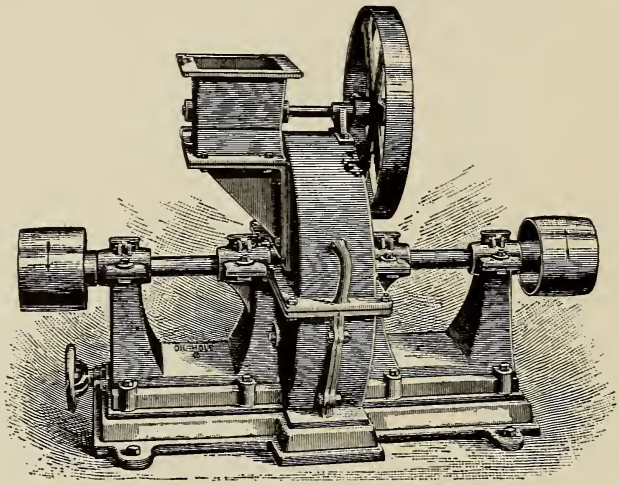


Fig. 40.—The Ross Pulverizing Mill.

It operates on the attrition principle, having two steel cages revolving in opposite directions at high velocity. The materials are fed into the hopper at the top and discharged from an opening under the casing.

Rotary Dryer.

There are various types of dryers for compounding ingredients. As a rule they are designed especially for individual use. One that is used in Europe to an extent is the rotary dryer shown in Fig. 41. This operates without vacuum, yet has a large drying capacity. It consists of a hollow cylinder, through the middle of which, a little below center, runs a hollow shaft. To this shaft, on the interior of the cylinder, are attached stirring blades. Against the walls of the cylinder on the sides are arranged steam pipes.

Referring to the illustration, *C* and *D* represent the ends of the hollow, steam-heated shaft. The blades on this shaft are represented by *H*. *A* is a hopper, through which the material to be dried is fed. *F* is the discharge port for dried material. *E*, *E* are hand holes. *G* is a stack for vapor exhaust. There may also be seen on the lower half of the cylinder, entrance and exhaust ports for the interior steam pipes *B*.

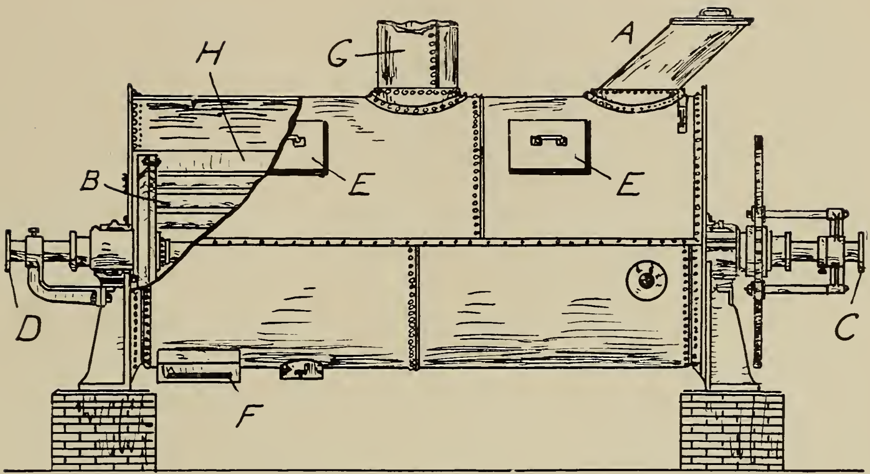


FIG. 41.—THE ROTARY DRYER.

AUTOMATIC WEIGHING OF COMPOUNDING INGREDIENTS.

The triple gang, automatic weighing machine shown in Fig. 42 is now being experimented with in large rubber factories. It is not yet

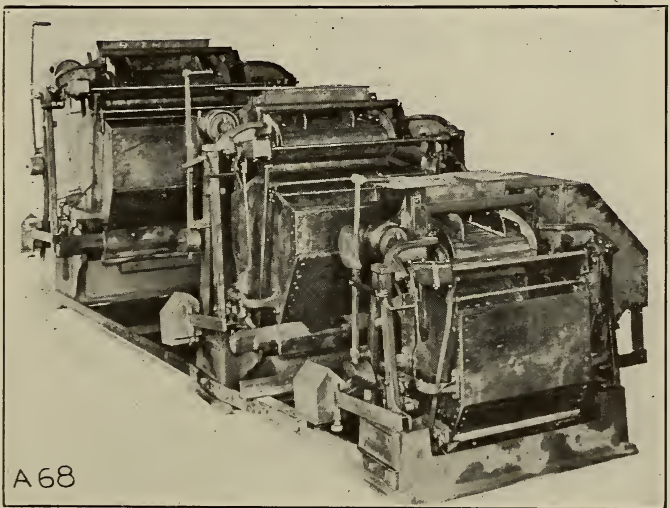


FIG. 42.—TRIPLE GANG MACHINE.

wholly adapted for rubber work but its possibilities are many. It is a swift, accurate and secretive weighing mechanism which works faster than any expert human weigher. It is already used in a variety of

industries where dry ingredients are weighed and batched. The suggestion is that a gang of these machins could handle the ingredients that go to make up a compound, one machine to weigh whiting, another litharge, still another sulphur and so on. Each machine takes its material from a bin, weighs it and delivers it into a common pan.

CHAPTER IV.

THE MIXING OR COMPOUNDING OF RUBBER.

DRY mixing, that is, the incorporation of various compounding ingredients into rubber, is very generally done on machines called mixers or grinders. These machines are also used for massing or breaking down, refining and warming.

The first rubber mixer of which we have any record was a machine made after the pattern of the "pug-mill" used in brick yards for the kneading of the clay. In this the rubber was treated with camphene to make it less refractory.

The next step was the use of heavy wooden rolls set in a wooden frame, a solvent still being employed to soften the gum so that it could be worked. From this it was not a long step to the iron rolls, which were found to wear much better, and were not affected by the camphene or benzine used in the sticky compound.

At this stage of the industry, it was discovered that heat softened the crude gum, and yet did not make it sticky as did the solvents. A practical application of this knowledge was the hollow steam-heated roll that was almost immediately produced, and that made possible "dry mixing."

The Chaffee Mixer.

Edwin M. Chaffee, one of the pioneers in the American rubber industry and a co-worker with Charles Goodyear, was the inventor of the first iron roll, steam heated rubber mixer. It was a two-roll machine, Fig. 43 showing Chaffee's own sketch of it. The drive roll *A* was six feet long, 27 inches in diameter, and chambered for steam. The second roll *B*, was of the same length and 18 inches in diameter. The larger roll was the fast one, the ratio being two to one. Above this roll were five bars *C*, 1½ inches thick, 12 inches wide and six feet long. These were placed side by side, three-quarters of an inch apart. Their lower edges were convex and by the screws *D* adjusted to any desired distance from the roll *A*. Similar screws *E* were used to adjust the distance between the rolls *A* and *B*. Beneath roll *B* was a movable feeding apron *F* passing over small rollers *G* and *H*. The operation of the machine was as follows:

The rubber, cut into small pieces, was spread upon the apron and carried between the rolls where the steam heated rolls softened and

sheeted it. This sheet then passed under the bars *C*. The spaces between the bars were filled with compounding ingredients in powder form and mixed with the rubber as it passed over the roll *A*.

A few of the first steam-heated grinders are still in existence, and are worthy objects of curiosity. These machines were invariably run by belts, a huge wooden frame standing by the side of the machine in which hung a fast and loose pulley. The pulley shaft was provided with a large gear driven by a pinion set near the floor. This pinion

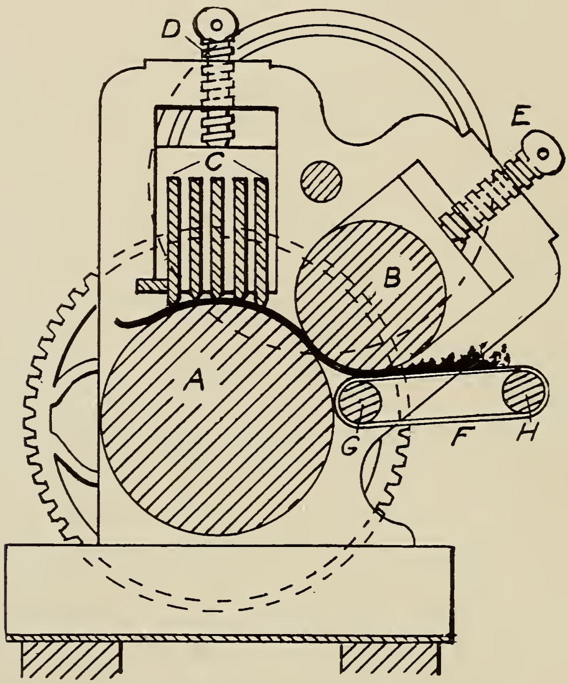


Fig. 43.—The Chaffee Mixer.

was on a shaft that ran across the back of the grinder, and at its extreme end held another pinion, which in turn, engaged with the large gear that turned the front roll. A similar shaft ran under the machine and, taking its power from the driving gear of the front roll by means of its pinion, turned the back roll. Thus the power was transmitted entirely around the grinder before it was applied to the rolls. This type, with modifications, continued to do its shiftless work for many years. It was a slow-running, noisy machine, mixing batches of twelve to fourteen pounds. Little by little necessity drove the manufacturers to make improvements. In this they were assisted by large machine,

builders who, learning what was needed—in many cases with difficulty—set themselves to build a practical, economical machine. The first thing they did was to throw aside the belted arrangement and put in a floor shaft. Then they hung a pinion on that shaft, and made it run one roll, while gears on the further necks of both rolls made one run the other. In the next place, the machine was made larger, the castings made heavier and the speed increased. Then came "Jumbo" mills, three-roll machines, electric drives, etc., etc.

The Mechanics of Mixing.

The amount of work done by a common mixing-mill depends upon the surface-speed of the rolls in inches per minute, and the length of the line of contact between the two rolls. For example, an ordinary mixing-mill, with rolls 15″ x 40″, running 15 revolutions a minute for the fast

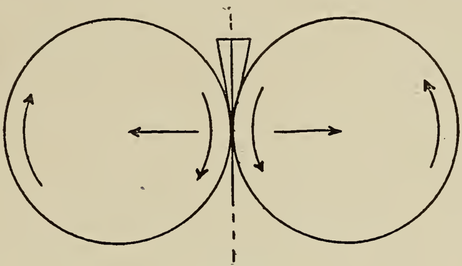


Fig. 44.

roll and 8 for the slow roll will mix a certain amount. Doubling the speed will double the product for a day's work,—or, the speed remaining the same, doubling the length of the rolls would double the product. Strength of materials prevents making the rolls with a working face of much more than 80 inches long without increasing their diameter to an impracticable extent. An increase in the diameter of the rolls to gain this necessary strength for a longer span between bearings, creates another difficulty. The three diagrams herewith illustrate this.

Fig. 44 represents a pair of 15-inch rolls and Fig. 45 a pair of 24-inch rolls, both drawn to scale. In each of these figures is a wedge of the shape the rubber would take in passing through the rolls. Its action is a simple wedge-action tending to split apart, exactly as an iron wedge would split a log. A slender wedge will split a log easily, while a blunt wedge would split it with difficulty. In the mixing-mill the same thing occurs. The wedge is the rolling bank of rubber, slender in one case, Fig. 45, blunt in the other, Fig. 44. This means two things—not only that the roll shall be increased in diameter suf-

ficiently to have the same strength for the increased span between bearings, but also shall be increased still more in diameter to withstand the greatly increased resistance of the rubber when in the shape of a narrow and powerful wedge instead of a blunt and weak one. This very increase in diameter to allow for the additional pressure of the rubber makes the wedge still more narrow and powerful, and the diameter must still be increased in strength on that account. This remedy rapidly aggravates the evil which it seeks to cure; so that, in doubling a working face between bearings, the diameter must be increased enormously, making a very radical change in the shape of the wedge and increasing all the general proportions of the machine in order to give the necessary strength to withstand the enormous pressure created by the action of this slender but powerful wedge.

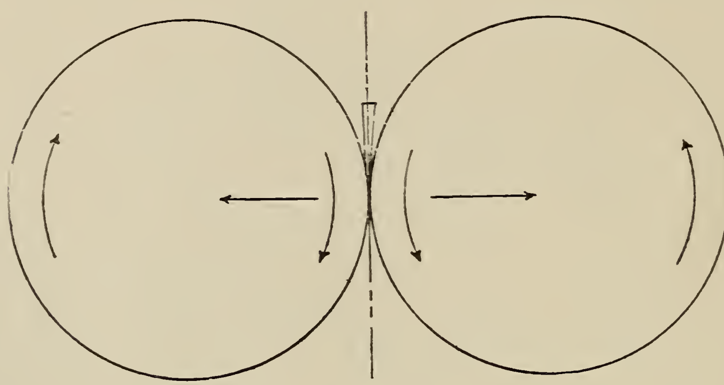


Fig. 45.

If the object sought were to split the machine, as in the case of the log, a wedge designed in this shape would be an admirable means to this end, but as the opposite is desired, a change in this direction is the worst possible move, for the purpose is to crush the wedge in the cheapest manner possible, not to split the machine. The latter can be avoided by using large quantities of metal in massive proportions to give the necessary strength for the required resistance, and if this were the only drawback to doubling the capacity of the present machines, having the same labor cost in operating as now, the few hundred dollars additional first cost which they would require would be no serious obstacle in their construction, considering the labor saving each year; but there is one consideration which makes their operation economically impossible. The power required for running a small mill at the ordi-

nary speed is about 15 horse-power. This is used up in two ways,—the internal work done upon the rubber, and the friction by the pressure of the rolls on the four bearings. The friction increases directly as the pressure, and, as we have seen, the pressure on these bearings when a slender wedge is used increases enormously, and this increases the friction and the consequent power on the bearings all out of proportion to the work done upon the rubber. So that a mill having the same surface speed, but having twice as long a working face as the old mill, would consume not twice the power, but very much more than twice the power of the old mill. When power is generated in very large quantities and under the best conditions, such as pumping-stations, etc., an annual cost of $40 per horse-power is considered very good practice, and is what is aimed at but only occasionally obtained. As generated in the average rubber-mill, it costs nearly $55 per horse-power per annum. One may readily see that any saving made in labor may be more than lost in the additional coal bill.

Theoretically, therefore, rolls should be made smaller, or run much faster to increase the output. The one difficulty in the past was that high speed created too much heat, and certain stocks were partly vulcanized before they were thoroughly mixed. Of course, the rolls cored for steam and piped for it were also piped for cold water. Various styles of coring were designed to cool rolls that were too hot.

The Cowen-Bragg Cooling Roll.

In the Cowen-Bragg roll, Fig. 46, the water entering through the neck passes up close to the surface of the roll, back and forth, and out at the opposite end from which it entered. The illustrations show a longitudinal section of the roll and a cross section on the line x x.

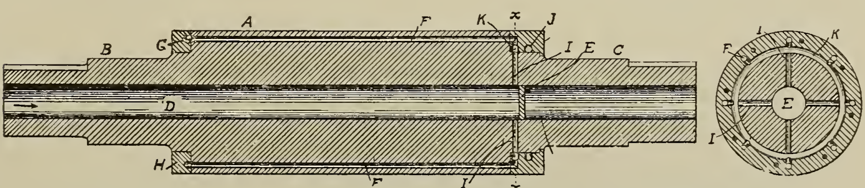


Fig. 46.—The Cowen-Bragg Cooling Roll.

In operation, water enters the passage D in the direction of the arrow. On meeting the dam E it passes outwardly through the passages I and the annular opening K into the channels F to the opposite end of the roll. Returning through annular passages G by another parallel channel F to the annular port J, through radial passages to the central

passage *D* at the opposite side of the dam *E*, from which point it is conducted away. It will be noticed that the water passes through the body of the roll, not only at its center but also very near the periphery where the cool water has opportunity to reduce the heat of the roll.

Bragg's Cooling Roll.

Another Bragg roll embodies a series of circumferential water channels near the surface, these being connected with the inlet and outlet by radial passages running to the center of the roll. The water

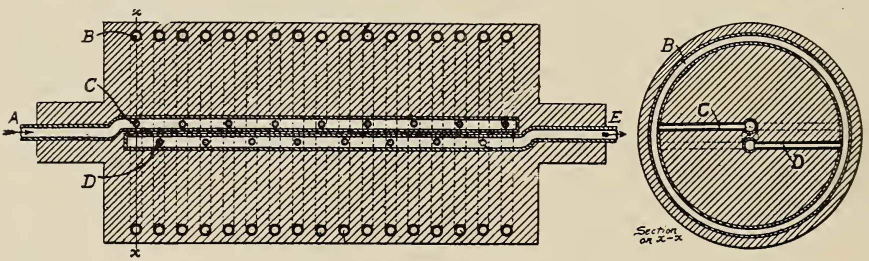


Fig. 47.—The Bragg Cooling Roll.

enters the roll at *A* (see Fig. 47) as indicated by the arrow and passes through the radial port *C* to the annular opening *B*. It then passes around the periphery of the roll and reaches the center through the radial port *D*, from which point it flows to the outlet *E* at the opposite end of the roll. This process is repeated, except that in the first inlet the water passes to the left toward the periphery, to the right in the second, to the left in the third, and so on. The return annular outlet pipes likewise lead alternatively to the right and left. In this way the flow of the water is in opposite directions from the coolest to the hottest parts of the roll. The water channels are iron pipes placed in the mould before casting.

The Bragg Built-up Roll.

During his investigations, Bragg found that the internal stresses in casting and in operation were less if the roll were built up in composite

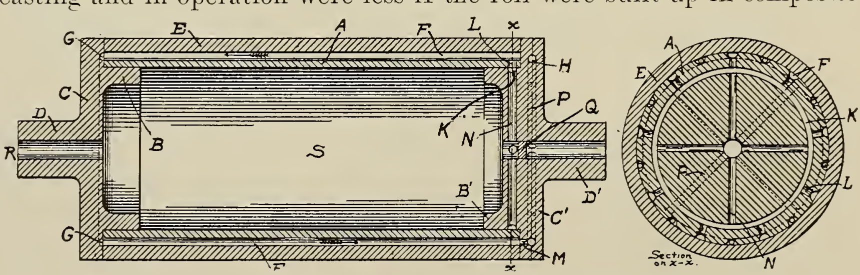


Fig. 48.—The Bragg Built-Up Roll.

form. He, therefore, constructed a hollow roll surrounded by an outer sleeve. Referring to Fig. 48, the inner roll *S* is mounted on the flanges *B* B^1 of the headers *C* C^1, each provided with a journal *D* D^1. Longitudinal grooves *F* are planed in the surface of the roll *S*. The outer casing *E* is then shrunk upon it. The course of the water for cooling is as follows: It enters at one end, fills the inner roll, and passes to the longitudinal grooves in its surface. It then flows through them, the length of the roll, and back through parallel grooves, then to the outlet in the neck of the inner roll at the opposite end from which it entered, where it is discharged.

Referring again to the drawing, water is introduced at *R* and fills the interior of *S*. It then passes through the radial passages *N*, to the annular groove *K*, then along the periphery of the inner roll through the first set of grooves *F*. It returns through the second set of longitudinal grooves into *H* and radial passages *P* and flows to the center at D^1 on the opposite side of the dam *Q* where it is discharged.

The Brewster Cooling Rolls.

One of Brewster's cooling rolls is shown in Fig. 49. It has internally projecting ribs *A* to provide strength and still to allow thin walls.

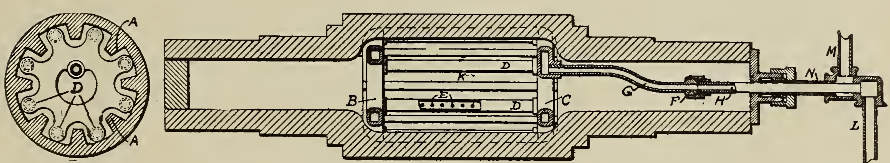


Fig. 49.—The Brewster Cooling Roll.

Two hollow headers *B* and *C* connected by perforated pipes *D*, form an interior cage. The header *B* is closed while *C* is connected to the inner end of the feed pipe *G*. This pipe has a ball joint *F* which allows it to turn with the roll while the pipe *H* remains stationary. Water enters the inlet pipe *L* and passes into header *C* and thence through the perforations *E* against the walls of the roll *K*. It fills the roll and is discharged through an annular passage between the pipes *H* and *N*.

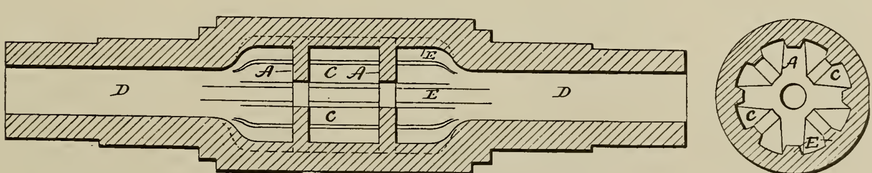


Fig. 50.—Another Brewster Roll.

Another type of roll invented by Brewster is shown in Fig. 50. This has two reinforcements *A A*, each having a hub center and four arms cast into the roll. Projecting inwardly from the walls of the roll are also radial ribs *E E*. These reinforcements strengthen the roll and leave clear passages *C C* from one end to the other.

The Norris Roll.

The Norris cooling roll, Fig. 51, has a thin outer shell *A* and radial partitions *C C* extending from the central hub *G* to the shell. These partitions do not extend the entire length of the roll but end at the shoulders D D^1, beyond which are end chambers E E^1. The inlet pipe *F* extends to the passage *H* which connects with the chamber *E*.

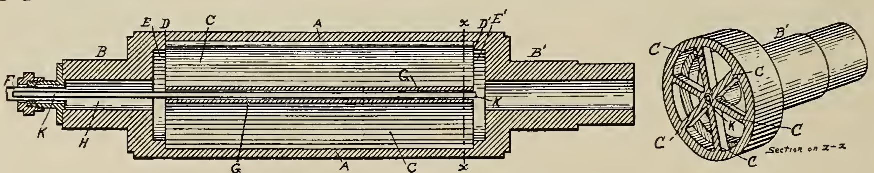


Fig. 51.—The Norris Cooling Roll.

The outlet *K* extends through the hollow hub *G* and connects with E^1. The steam or water is admitted through the pipe *F*, passes through the chamber *H*, through *E* and into the openings between the radial partitions *C C*, back through the chamber E^1 and out through the tube *K*.

The Standard Mixer.

Mixing machines or mixers for incorporating various fillers and ingredients uniformly into the crude rubber are made in many different sizes, and operated at various speeds to suit the ideas of the manufacturers and the particular line of rubber product. Formerly a two-roll mixing mill with rolls 15 inches in diameter, 36 or 40 inches long was considered large. Now, some manufacturers have mixing mills with rolls 24 inches in diameter and 84 inch face, or even larger.

The standard machines are now made with rolls 16 x 40, 18 x 48 to 54, 20 x 60 and 22 x 72 inches. The size best adapted depends on the compound to be mixed, but for general use a 20 or 22 x 60 inch mill is about as large as the operator can handle to advantage

These machines consist of two rolls made from either chilled or dry sand iron, set in a heavy frame. One roll has a driving gear on one end which is driven by a pinion on the shaft underneath; on the other end of the drive roll is a gear which meshes into another gear on the end of the front roll. These gears are of different sizes

to give a friction or different speed to the front roll from that of the back roll, which assists in forcing the compound into the rubber. A standard friction has a ratio of about 1½ to 1, that is, on a 20 inch mixing mill running the drive roll, say 20 revolutions per minute, the front roll should run 13 to 14 revolutions per minute, giving a surface speed to the drive or back roll of 1256 inches, or 35 yards, and to the front roll of 838 inches, or 23 yards per minute. Some manufacturers prefer more, some less friction; therefore, the friction used in factories varies from even speed up to 2½ or even 3 to 1; but a good standard

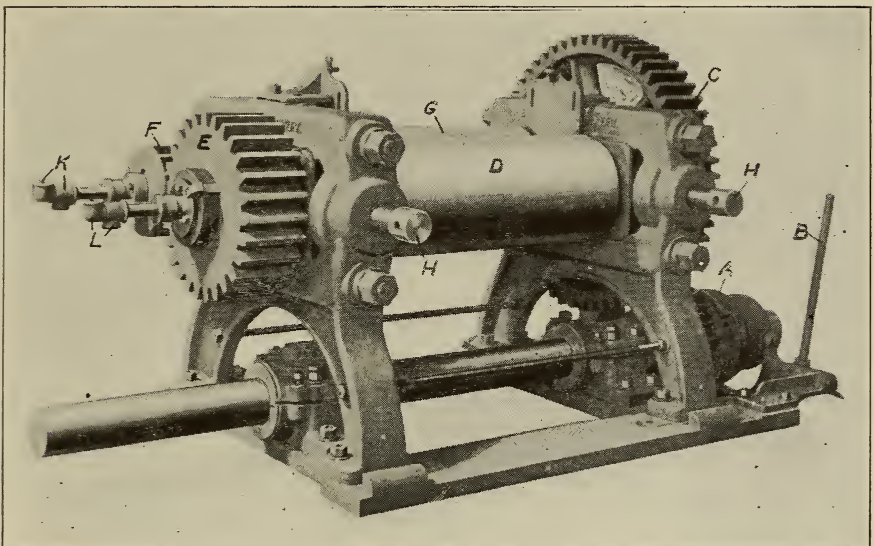


Fig. 52.—Standard Single Geared Mixer.

on ordinary work is 1½ to 1. Both rolls are either cored or bored, so that a constant flow of cold water can be maintained to keep them from getting too hot from friction. If rolls are not kept cool, the rubber will burn.

Beneath each mixer is a wooden pan lined with zinc into which ingredients drop, that are not at first caught up by the rubber. The operator with a brush and shovel gathers this up and adds it from time to time to the mass that is being mixed. The pan, by the way, should be so set that it can easily be withdrawn at any time. The only tools that the mixer uses are the shovel, brush, and a knife. The latter is used for cutting the sheet from side to center and folding it in to insure even mixing, and in the final cutting off of the sheet when the batch is thoroughly mixed.

The mill operator uses his own judgment as to the heat of the rolls necessary to mix various stocks. His test is to run his hand over the rolls and turn on steam or water as his experience may direct. His judgment also directs the cutting off of the batch and rolling it into a log or sheeting it into a thick slab when he believes the mass to be homogeneous.

Mixers and indeed washers and calenders are fastened down by anchor bolts set in concrete foundations, or in more modern practice on a continuous bed plate of iron, cast in sections which allows of setting the machines at any distance from one another that may be convenient. A channel below the middle of the bed plate gives room for steam and water pipes, drip, etc.

Fig. 52 affords a good example of the standard single geared mixing mill. *G* is the drive roll, *D* the slow roll, *C* the main driving gear, *E* and *F* the reducing gears. *H, H* are screws for adjusting the rolls. *A* is the clutch for starting and stopping the machine and *B* the lever for operating it. *K* and *L* are steam and water connections for heating and cooling the rolls.

In a rubber footwear plant having three 20 x 60 inch mixing mills with dry sand rolls, the daily product for 10 hours on a month's run was 4,000 pounds a day, consisting of compounds for all kinds of uppers, solings, heels, friction, coating, etc. On some compounds such as heels the product was 6,000 pounds a day, but the average was as given above. The speed of these machines was: drive roll, 26 revolutions per minute; friction gears, 17 and 27 teeth, front roll, 16⅜ revolutions per minute.

In installing a number of mixing mills on a line of shafting, it is safe to figure on horse-power as follows: each 15 x 36 mill, 25 horse-power; 16 x 40 mill, 30 horse-power; 18 x 54 mill, 40 horse-power; 20 x 60 mill, 50 horse-power.

For very heavy work the mixing mill is often double geared, that is, having a back shaft driven with gears from the main line, and a pinion and drive gear to operate each roll.

In any mixing room there is bound to be a great amount of impalpable and often palpable dust in the air. This settles everywhere, sometimes on freshly calendered stocks which prevents adhesion in making up; sometimes on window ledges, beams and machinery and is later jarred off causing the same trouble. It is therefore well to have exhaust hoods over the mills so that all dust be removed before it can do harm. There is a further and more important reason for such hoods. Workmen are sometimes injured by inhaling floating

dust if not thus protected. Certain volatile chemicals also throw off fumes, which, if inhaled, result seriously.

The Haubold Transparent Cover.

It is sometimes desirable to cover the rolls of mixing mills to keep the dry dust from flying. For this reason Haubold introduced a

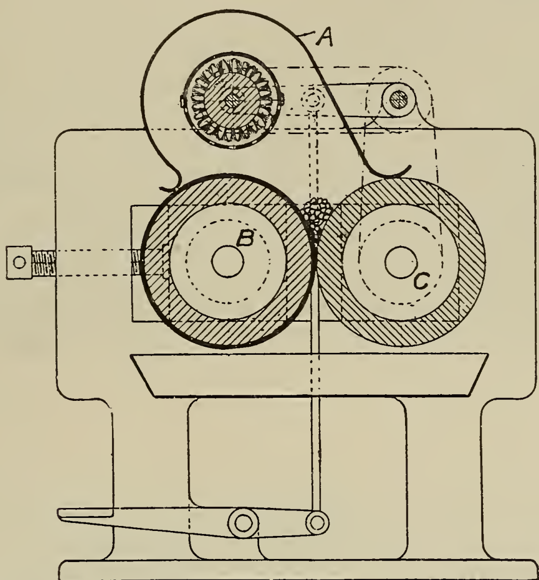


Fig. 53.—The Haubold Mixer with Transparent Cover.

mixer having a cover made of celluloid. This cover is shown at *A* in Fig. 53, enclosing the mixing space above the rolls *B* and *C*. It is really part of a feeding device which both sifts and feeds the compounding ingredients upon the rubber, while the mixing is in process. It is rarely necessary to add such a feed in ordinary mixing machines. When it is used, however, Haubold's celluloid cover prevents the light powders from flying and saves the mill tender much discomfort.

Refiners.

The best grades of stock are usually refined after being compounded. A good standard refiner is equipped as follows: one 18 x 32 inch chilled roll, one 12 x 32 inch chilled roll. The 18 inch roll runs about 26 revolutions a minute, the 12 inch roll 16 revolutions a minute.

Refining is passing compounded stock between such rolls set closely together, thus breaking up small particles that may be present

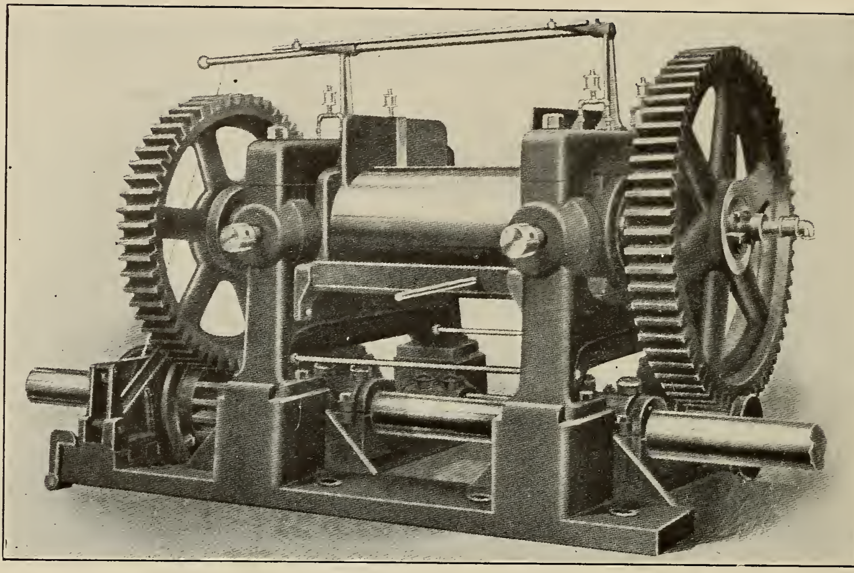


Fig 54.—Double Geared Refiner.

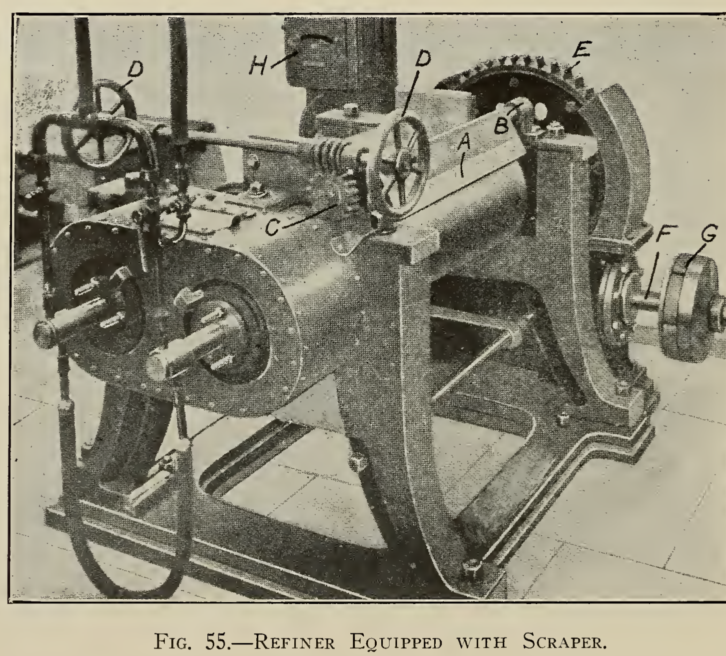


Fig. 55.—Refiner Equipped with Scraper.

and making the stock more homogeneous. The adjusting screws are made with finer threads than on mixing mills, and a scraper is placed over the fast roll to remove sticky stock. This scraper is a long knife often called a "doctor," and is mounted on the frame of the machine in such a manner that it comes in contact with the roll. Sometimes it is hinged so that it can be thrown up out of the way when not needed. When in use it may be set hard against the roll by counter-weights, by a lever or by worms and worm gears.

Fig. 55 shows a machine equipped with a scraper, shown at *A*. It is pivoted in bearings *B* and is raised or lowered by the worm gear *C* through hand wheels *D*.

Rubber is often massed on one mill and mixed on another. The "Jumbo" mill shown in Fig. 56, both masses and mixes, the partition *A* allowing it to serve as two machines in one. The partition is V-shaped

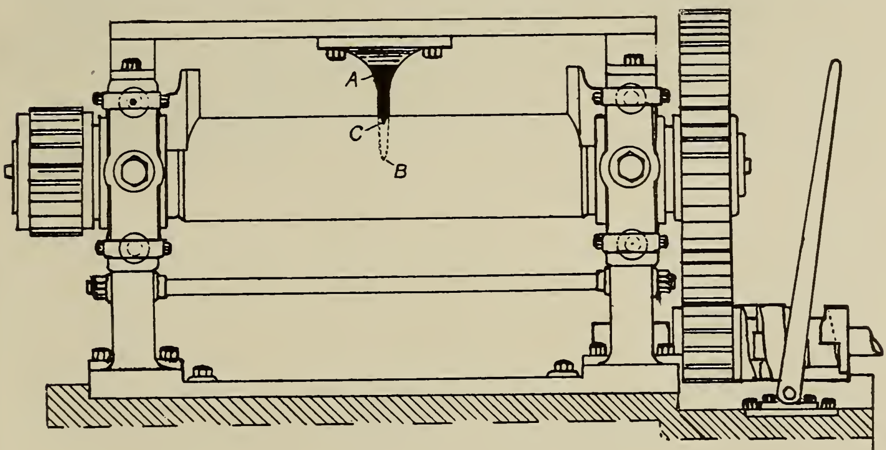


FIG. 56.—"JUMBO" MILL WITH PARTITION.

and extends down between the rolls at *B*, and on the outside to the point *C*. This divides the mixing surface into two parts. The rubber is placed between the rolls on one side of the partition where it is thoroughly massed. It is then removed and placed on the other side where the mixing is done, while a new batch is being broken down in the first side.

CRACKERS.

Crackers are standard two-roll machines, made with corrugated chilled rolls and used for breaking down fibre stocks, etc.

Standard sizes for crackers are 12 x 24, 15 x 24, 16 x 30, 18 x 36, etc. Best results are obtained from crackers by using friction of

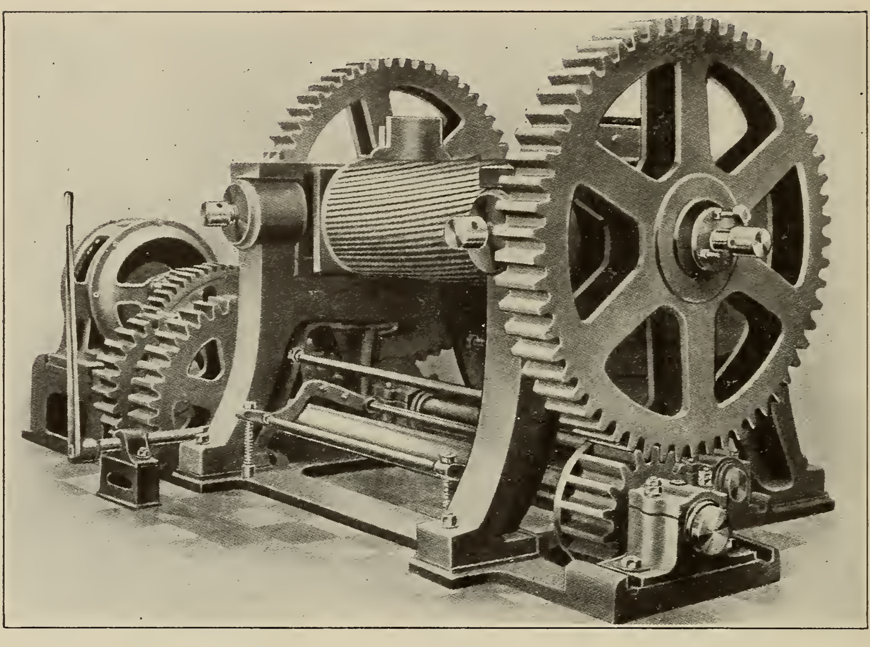


FIG. 57.—DOUBLE GEARED CRACKER.

2 or 2½ to 1 on surface of rolls, the rolls being cut with about four corrugations to the inch and a spiral of about three inches per foot.

THE PEARCE MECHANICAL FEED.

The Pearce machine mixes compounding ingredients and feeds them into the mill. The operation of this machine, shown in Fig. 58, is as follows:

The materials are weighed and placed in the box *A* in the compounding room. This box is then taken to the mixer and placed in the case *B* above the cylinder *C*. It has a sliding bottom *D*, operated by racks *E*, pinions *F* and hand wheel *G*. When the box is in position the bottom is opened, allowing the compounds to fall into the mixing cylinder *C*. A clutch is then thrown in, which revolves stirring blades *H*, thoroughly mixing the contents. Then a second clutch is thrown in, opening out the slides *K*, and the material falls evenly into the mill between the rolls *L* and *M*. This feeding may be done slowly or rapidly as the work requires. The mixing cylinder is driven through a chain *N* and sprockets *Q* and *R* attached to the drive roll *L*. The mixer can be attached to mills with rolls of any dimensions.

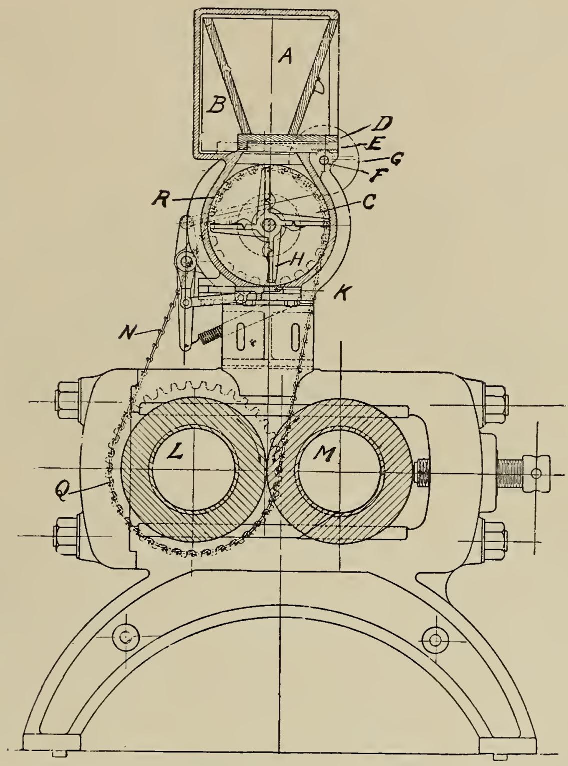


FIG. 58.—THE PEARCE MECHANICAL MIXER AND FEEDER.

THE BRAGG AUTOMATIC MIXER.

The Bragg automatic mixer, Fig. 59, is essentially a two-roll mixer combined with an endless feeding apron. This apron runs under the rolls and up and partly over the front roll, so that the material that would ordinarily drop into the pan is automatically returned between the rolls. The dotted lines in the drawing indicate the position of the apron before the mixing begins. This apron passes over a fixed roller *D*, a spring tension roller *E* and a movable roller *F*. The latter is attached to a pair of swinging levers *G* and handles *H* by which the apron is raised into contact with the roll *B*. A cross bar between the handles *H* carries brushes *K* which clean the apron. To prevent lateral play, the apron has a rib on the inner side which runs in a groove in the roll *B*. There are also end collars on the rollers which assist in keeping the apron in line.

In operation, the apron keeps a sleeve of rubber against the roll and carries the slack toward the top where it laps and forms a fold.

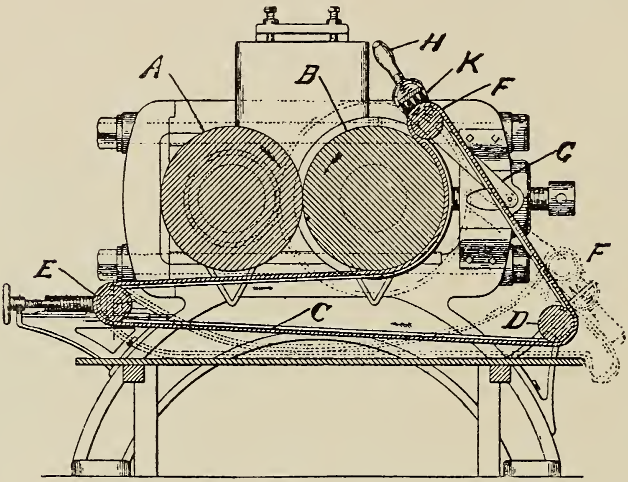


Fig. 59.—The Bragg Automatic Mixer.

Cowen also designed a machine which is so nearly like that patented by Bragg, that only a brief description is necessary. It is a two-roll mixer, with an adjustable apron for conducting the material from beneath the rolls, around one of them and to a hopper at the top.

The Olier Mixer.

Fig. 60 shows a French two-roll mixer which, with one or two differences, is one of the standard two-roll type. The additions are.

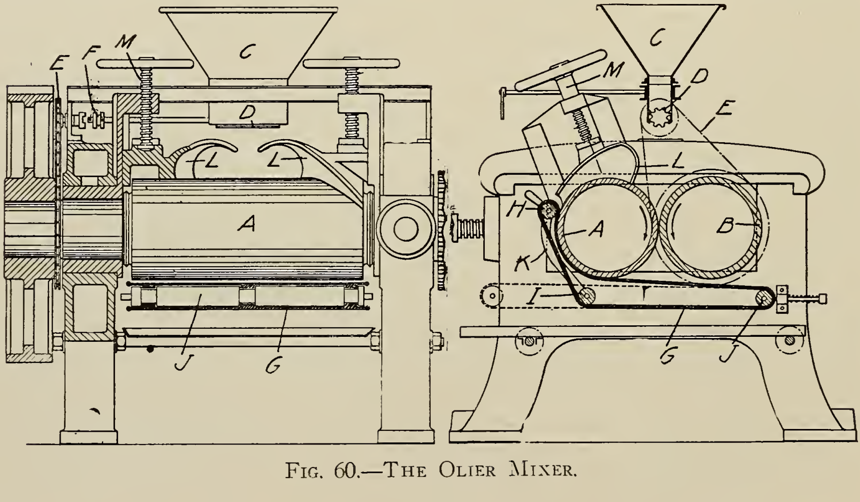


Fig. 60.—The Olier Mixer.

an endless feed apron similar to that used in Bragg's automatic mixer, and two adjustable plowshare blades. These are set so that the partly mixed sheet is turned in toward the middle of the rolls. In other words, it does continually what the mill tender does intermittently, turns the sheet away from the ends of the rolls and into the middle.

The two drawings show an end view and a side elevation, both partly in section. The machine has two rolls *A* and *B*. Above them is a hopper *C* for compounding ingredients. At the bottom of the hopper is a cylindrical distributor *D*, driven by a chain *E*. This distributes the ingredients over the rubber. To catch and carry back the unmixed ingredients to the roll *A*, an endless apron *G* is carried upon the rollers *H*, *I* and *J*. The roller *H* is mounted upon two side arms *K*, so that the apron may be raised or lowered. At the ends of the roll *A* are two blades *L*, shaped like plowshares. They are raised or lowered by hand-screws *M*. When in contact with the roll *A* they scrape the rubber from the roll and turn it over.

The Watkinson Three-Roll Mixer.

In Fig. 61 is the Watkinson mixer with the rolls placed as shown in the drawing on the right. The driving shaft *A* bears a pinion *B*

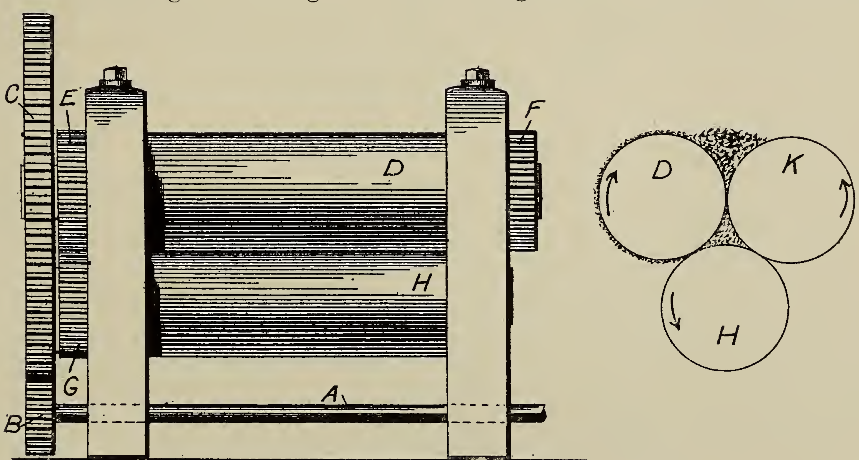


Fig. 61.—The Watkinson Three-Roll Mixer.

which drives the large gear *C*, keyed to the shaft of the main roll *D*. The gear *E* meshes with a gear *G* on the roll *H* while the gear *F* meshes with a similar gear on the roll *K*. The batch is shown between the rolls *D*, *K* and *H*. As the rolls revolve in the direction of the arrows the material below the rolls *D* and *K* is passed between the rolls *D* and *H* and carried back by the main roll to the starting point.

The Wicks Three-Roll Mixer.

The Wicks mill, Fig. 62 has three rolls, *A, B* and *C,* supported in end frames *D*. The roll *B* is adjustable horizontally by screws *E,* to the two rolls *A* and *C*. The front roll runs at friction speed of 1½ to 1 to the back rolls. In operation, the rubber is placed between the

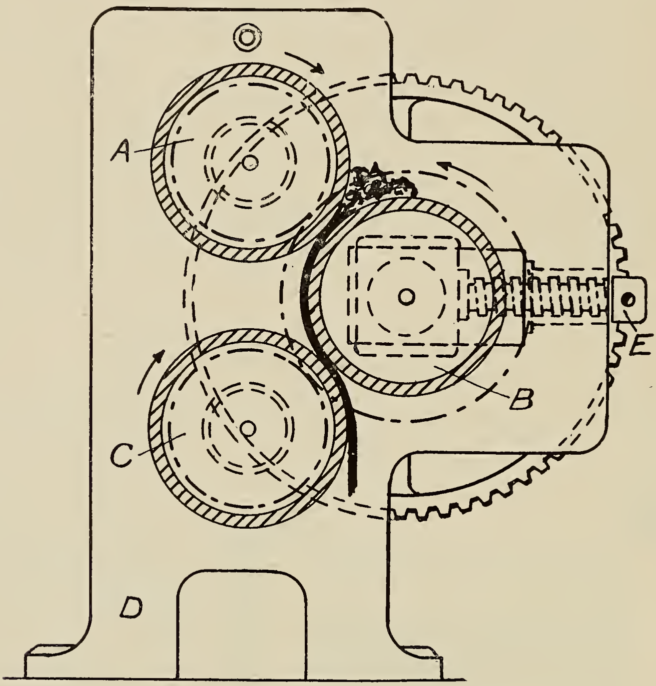


Fig. 62.—The Wicks Three-Roll Mixer.

rolls *A* and *B* and forms a sleeve around *B*. The compounding ingredients are added and the two back rolls which revolve at a higher speed, force the ingredients into the rubber on the slower front roller.

The Obermaier Mixer.

In the Obermaier mixing mill, Fig. 63, the rolls are corrugated, the corrugations meshing with each other so that the faces are in contact. The roll *A* is the fast roll; *B* is the slow roll. Arranged longitudinally of the roll *B* is a scraper-knife *C* on a cross bar *D*. This knife has a corrugated edge which conforms to the shape of the roll. On the opposite side of the machine is a similar knife *E* mounted on pivoted arms

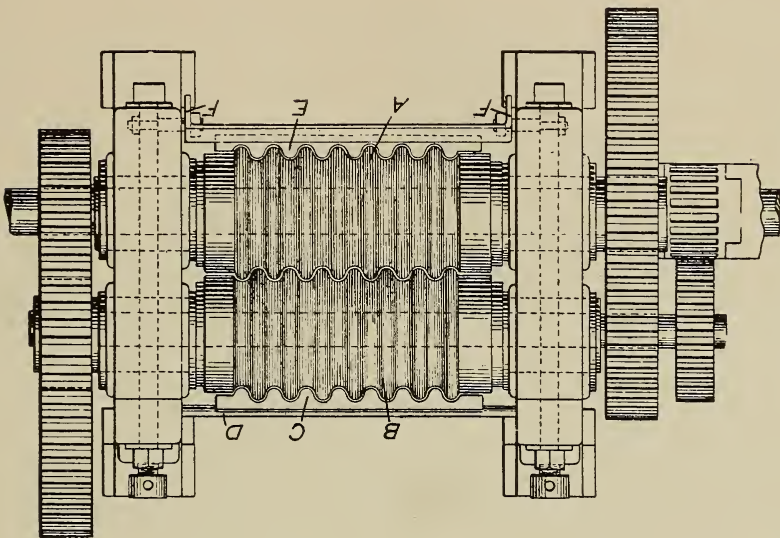


FIG. 63.—THE OBERMAIER MIXER.

F, allowing the knife to be swung in or out of engagement with the roll *A*.

MASTICATORS.

After a number of years of experimenting, with little success, in endeavoring to devise a method of uniting pieces of crude rubber, Thomas Hancock, the pioneer in the rubber industry in England, finally constructed the machine shown in Fig. 64. It was his intention to tear the rubber into small pieces with this machine so that they might more easily be united by immersing them under pressure in hot water. The machine however massed them and led up to the masticator of the present day.

The machine consisted of wooden frames *A A* bolted together, a hollow cylinder *B,* a roll *C* in the center of the cylinder, and a crank *D*. Above the cylinder was an opening *F* through which the rubber was introduced. Both roll and cylinder were provided with sharp metal teeth. This first machine had a capacity of only two ounces of rubber but was soon succeeded by others of greater capacity, one of which, known as the "Mammoth," is shown in Fig. 65.

Masticators today are used in washing rubber, in breaking down and in mixing. The masticator mixer is very similar to the masticator washer shown in Chapter I. It of course is not a wet machine, and

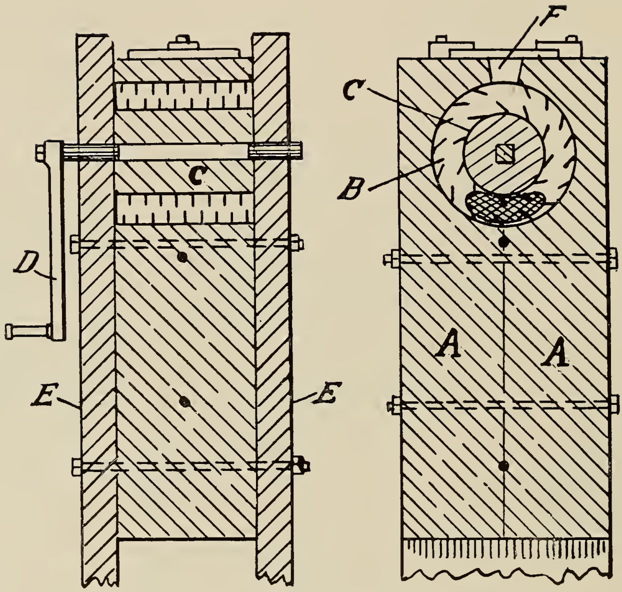


Fig. 64.—The Hancock Original Masticator.

is not fitted with mud traps, etc. The walls are also chambered for steam and in some cases fitted for vacuum.

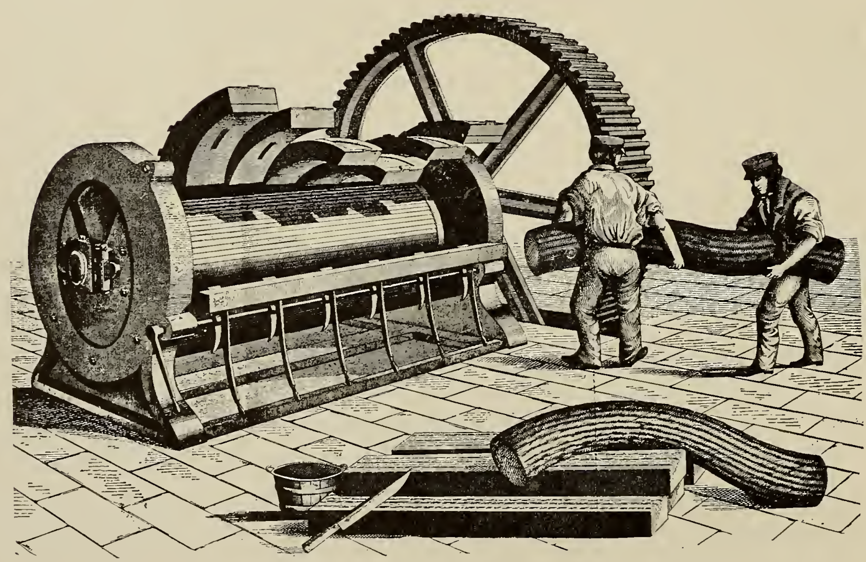


Fig. 65.—The Hancock "Mammoth" Masticator.

The Universal Masticator.

In the illustration of the Universal Masticator, Fig. 66, *A* is a chamber, in which revolve two blades *B* and *C*. The front side or cover *D* is supplied with counterweights *E*, to aid in opening. *F* is the hopper in which the compounding ingredients are placed and from which they

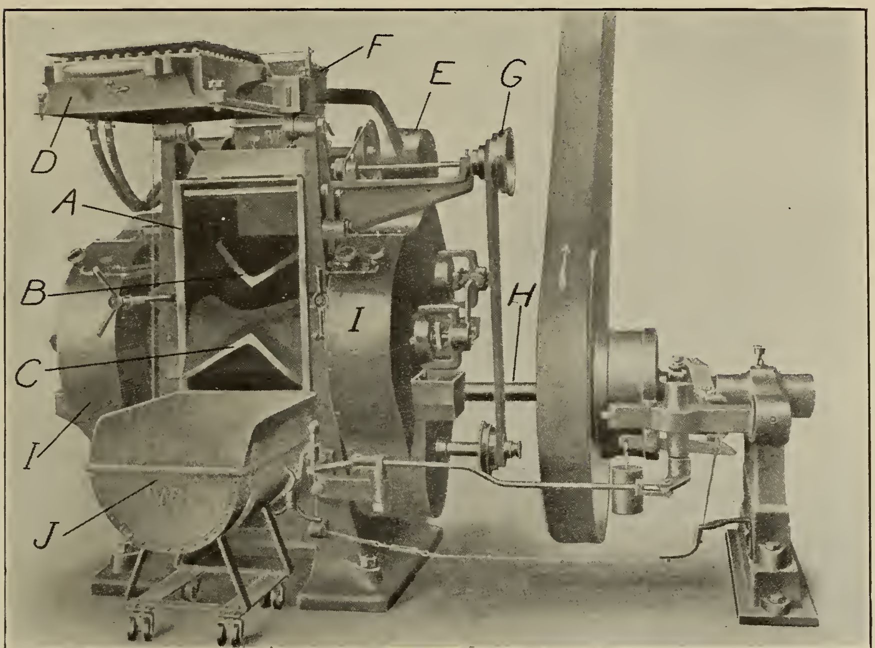


Fig. 66.—The Universal Masticator.

are fed automatically and continuously, at any desired speed, by the cone pulley *G*. Power is transmitted from the main driving shaft *H* to the blades *B* and *C*, by gears and pinions covered by guards *I*. The trough *A* and the door *D* are jacketed, and the blades *B* and *C* are hollow for heating or cooling. The rubber is placed in the chamber *A*, and when thoroughly masticated, the compounding ingredients are fed to it from the hopper *F*. When the batch is finished the door *D* is opened, and the machine automatically unloads into the car *J*.

The Bridge Masticator.

Another masticating machine is that built by Bridge, two exterior views of which are shown in Figs. 67 and 68. In this only one mixing

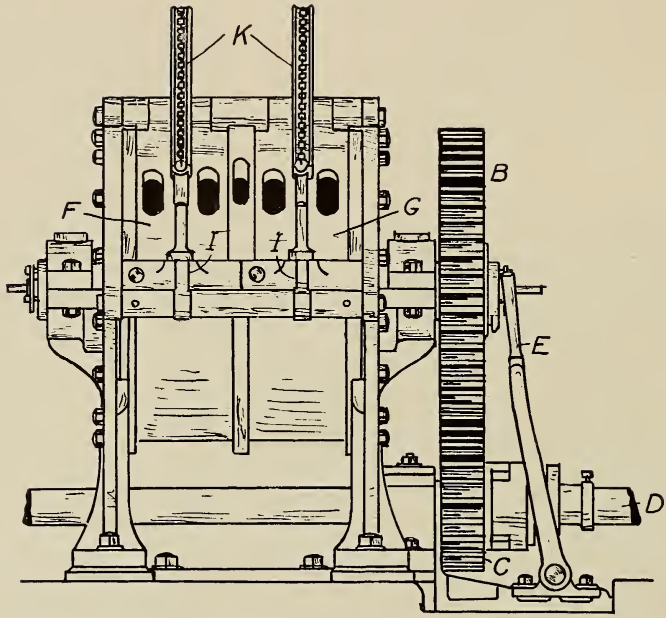


Fig. 67.—The Bridge Masticator.

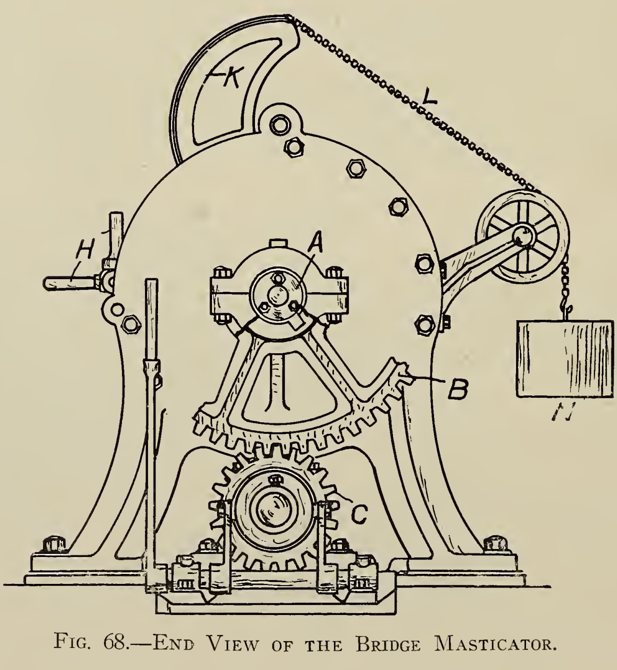


Fig. 68.—End View of the Bridge Masticator.

roll is employed which kneads the mass against the serrated sides of the cylinder that encloses it. This toothed roll is driven by the large gear *B*

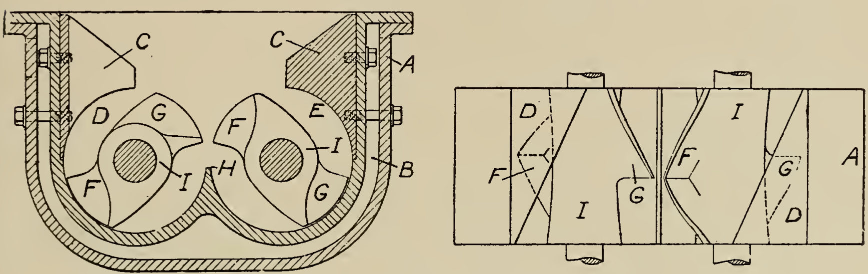


Fig. 69.—The Pointon Masticator.

from the pinion *C* on the main driving shaft *D,* and thrown in or out of operation by the hand lever *E.* Counterweights *N* are used in opening the doors *F* and *G.* When closed these doors are held tightly shut by levers *H* which slide into slots *I.* The cylinder and the roll are chambered for steam, and the doors fitted with air outlets.

The Pointon Masticator.

In Fig. 69 is shown the Pointon masticator in end section, and a top view of the rolls or blades. The body or trough *A* is provided with a steam jacket *B.* The trough forms two semi-cylindrical chambers *D* and *E,* in which the blades rotate. At the lower portion the saddle *H* is formed. The masticator blades are both V-shaped and spiral. Rubber is carried around the two cylindrical chambers from one

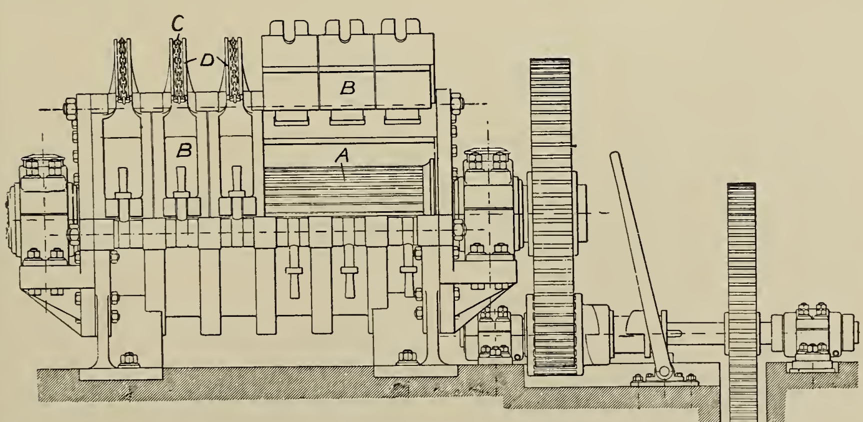


Fig. 70.—The Troester Masticator.

to the other by the blades *F* and *G*. The V-shaped blade of one roll working with the spiral blade of the other, forces the rubber toward one end of the trough while the other blades force it toward the opposite end. The result is thorough mastication.

The Troester Masticator.

The Troester machine, Fig. 70, employs one corrugated roll *A* by which the rubber is kneaded against the sides of the trough. The six doors *B* are placed side by side, extending the full length of the trough. These are arranged to be opened independently by chains *C* passing over quadrants *D* and over pulleys supporting counterweights.

The Cooling Table.

Many stocks, if left in rolls as they come from the mixer, hold enough heat to semi-vulcanize the inside. Such stocks should be

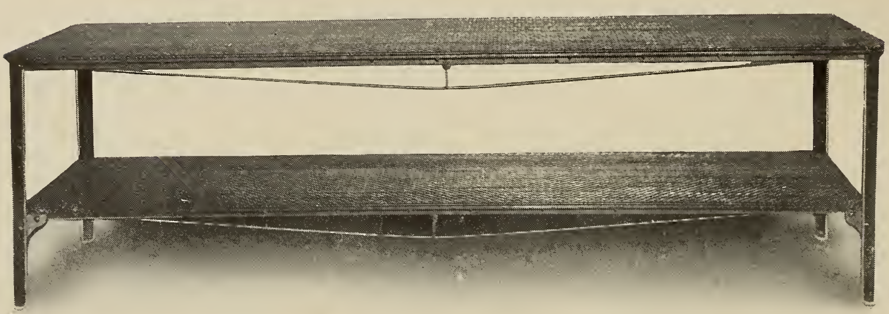


Fig. 71.—Mill Room Cooling Table.

taken from the mill in slabs instead of rolls and laid upon cooling tables. These tables have steel frames and tops of stiff wire cloth. They are made with two or three decks and have a capacity of one to two tons of mixed stock. Fig. 71 shows a two-deck table, which has a capacity of about one ton.

Continuous Bed Plates.

Fig. 72 shows a mixing mill mounted on a continuous bed plate. It consists of two heavy castings *D* each having two T-shaped slots

E and F running their entire length. In the slots E the bolts G are placed to support the bearings of the driving shaft H. The bolts

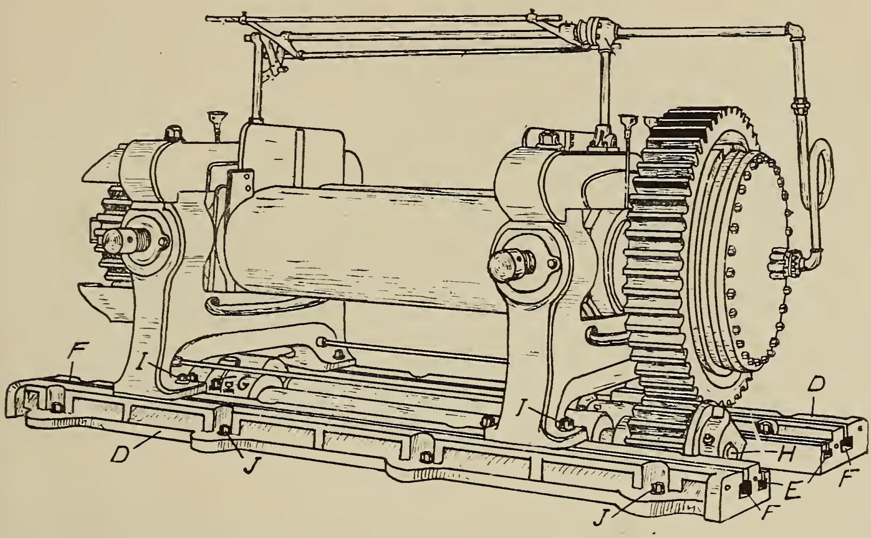


FIG. 72.—MILL ON CONTINUOUS BED PLATE.

I in the base of the machine frames are placed in the larger slots F. In this way machines of any length may be quickly mounted when the bed plates are once secured. The plates are usually attached by means of anchor bolts J set in concrete. Where a number of machines are set in line, several lengths are bolted together, so that the slots E and F are continuous.

The subject of safety devices in connection with mixers is of first importance. This will be found fully covered in the chapter devoted to Calenders. Motor drives applicable either to mixers or calenders are also there described.

CHAPTER V.

PREPARING FABRICS FOR CALENDERING AND SPREADING.

THE preparation of fabrics for a coat of rubber or for frictioning is a very necessary preliminary. The chief trouble maker, if such preparation is dispensed with, is moisture. To appreciate how much moisture is contained in an apparently dry bolt of duck, one needs only to put it in a vacuum dryer and note the amount of water extracted. There are also imperfections such as knots, nap, wrinkles, etc., which must be removed before the fabric is perfect. For this purpose, special machines are employed.

The Farrel Six-Roll Dryer.

In Fig. 73 is shown the Farrell six-roll drying machine. Each of the six rolls is 12 inches in diameter and any length up to 60 inches.

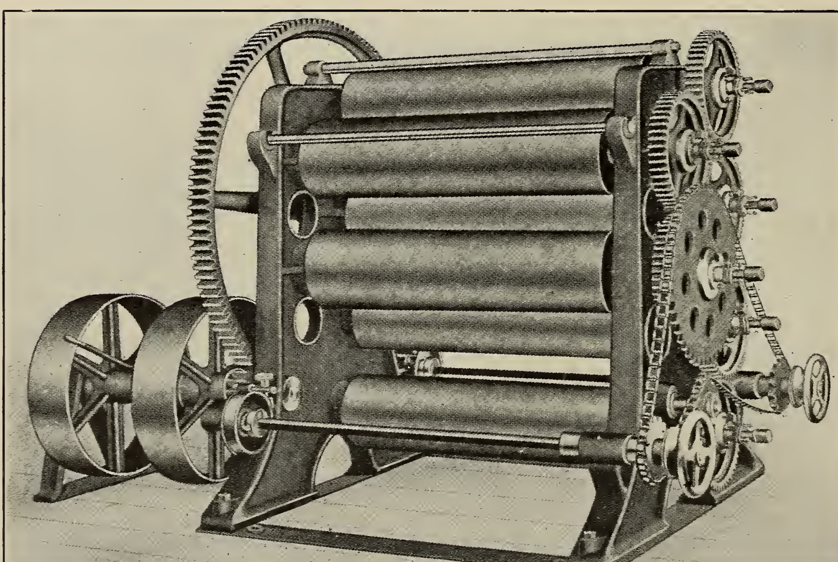


Fig. 73.—The Farrel Six-Roll Dryer.

They are made hollow and are fitted with steam connections. For high pressure, say 40 to 80 pounds per square inch, the rolls are made of cast iron and turned smooth. For low pressure of about 12 or 15 pounds per square inch, the rolls are made of copper. The machine is

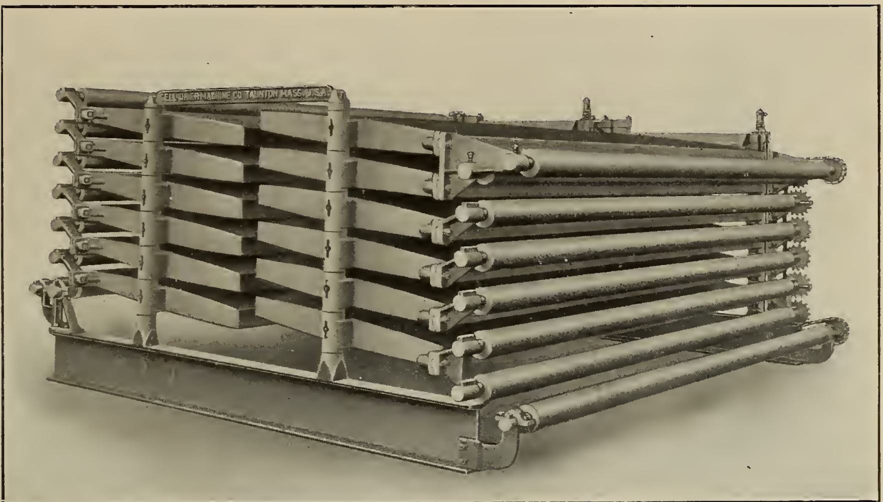


FIG. 74.—THE MULTIPLE CELL DRYER.

geared to run in either direction, that the fabric may be run through as many times as necessary. At each end of the frame there is a combination wind-up and brake so that the fabric may be wound up either at the front or back. The driving pulleys are 36 inches in diameter with a 6½ inch face and are run at 50 revolutions per minute. The machine is 7½ feet high and where the rolls are 5 feet long a floor space of 7 x 10 feet is necessary.

THE MULTIPLE-CELL DRYER.

The machine shown in Fig. 74 consists of twelve hollow cast-iron boxes. It is really a stack of boxes without side frames and is a good example of unit construction. That is, almost any number of individual cells can be assembled in a stack to suit requirements. Each cell contains three baffle plates to increase the radiation and is set on an angle so that the condensation is taken care of by gravity. Each cell is provided with three lugs, two on one side for steam inlet and outlet, and one on the other as a support. The lugs of the different cells are doweled and keyed and coincide, so that when steam is admitted to the top cell it passes through all of them to the bottom. A brass sprocket roller is journaled on one end of each cell. The sprocket rollers in the stack are driven by an endless chain, which comes in contact with all of them. The fabric passes over these rollers and the heated cells, first over the top pair, then against their under surfaces,

then over the surface of the second pair and so on. At each end of the machine is a wind-up and brake so that the fabric may be run back and forth as many times as necessary.

Fabric Stretching Machine.

Taking the stretch out of fabrics, particularly those used in belting and tires, is very necessary. Fig. 75 shows a front view of a machine for this purpose.

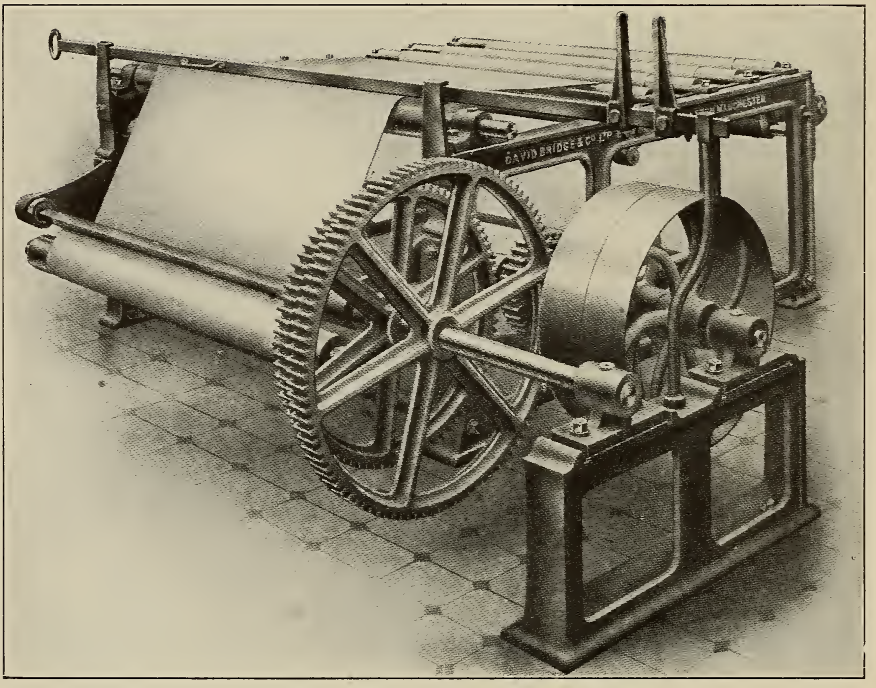


Fig. 75.—Fabric Stretching Machine.

It is simply a frame, carrying a series of tension bars, take off and wind-up rollers. The cloth starts at one end, is threaded over and under the bars and wound up on a floating roller at the front. This roller is supported on the ends of two levers pivoted in the center, with counterweights on the opposite ends. This presses the fabric against a square shaft. The friction revolves the take-up roller and winds up the fabric.

Cloth Measuring Device.

Fig. 76 shows a device which is often attached to calenders and fabric coating machines for measuring fabrics. It may be attached to

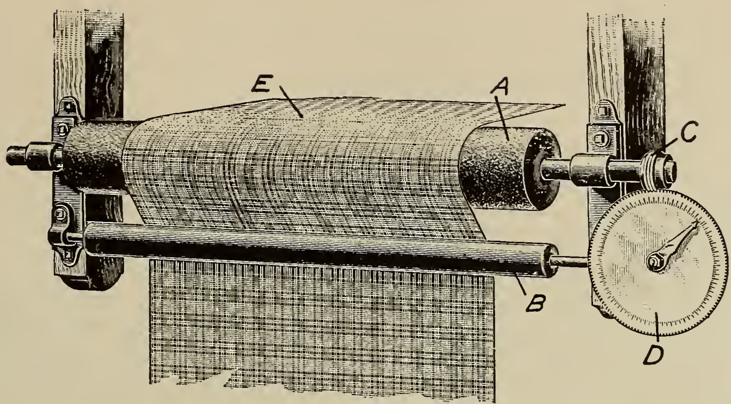


Fig. 76.—Cloth Measuring Device.

the frame of the machine or to the frame of a separate wind-up roll. The cloth *E* passes from the machine over the measuring roller *A* and under a tension roller *B*. On the shaft of the measuring roller is a worm gear *C* which engages the teeth in the circumference of the dial D, the pointer being stationary. In most cases the measuring roll is one yard in circumference and the dial is graduated accordingly.

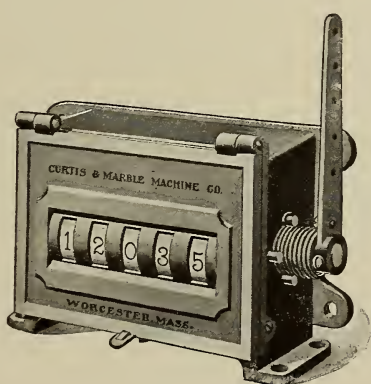


Fig. 77.—Cloth Measuring Counter.

Fig. 77 shows a counter for registering up to 100,000 yards at a time. This is used with measuring rolls one yard in circumference, a small rod connecting a crank pin on the end of the measuring roll shaft with the lever of the counter. This device is so arranged that it may be set back to zero at any time.

Singeing Machines.

In the manufacture of certain kinds of rubber-coated cloth it is essential to get rid of the fuzz left after spinning and weaving. Except in certain kinds of woolen fabrics this is done by singeing machines. In cotton cloth the singeing is sometimes done by passing the yarn before spinning through a flame, but more commonly the work is done after weaving.

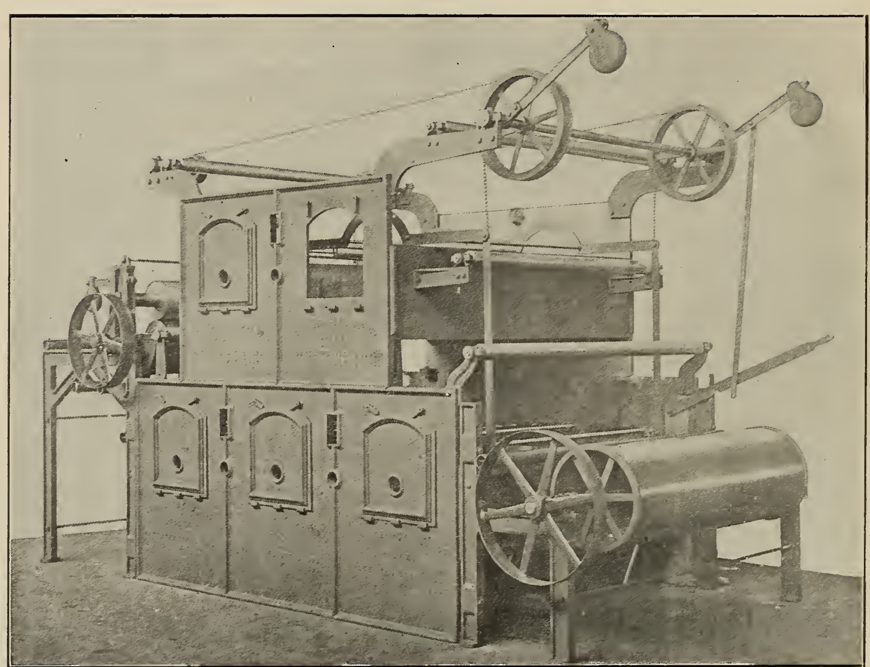


Fig. 78.—The Granger Plate Singeing Machine.

There are two types of singeing machines, or singeing houses, as they sometimes are called. In one the heat is applied by an iron plate under which oil is burned, the other uses a gas flame. In either case the essential features are: Steady heat applied evenly over the whole surface, an even speed so adjusted that the fuzz will be burned off without injuring or scorching the fabric, a draft so arranged that it will remove the burnt particles without causing any irregularity of the flame.

Fig. 78 shows the Granger plate singer. It may have any number of plates from one to five, but in any case the lower deck contains one

more plate than the upper. The iron frame plates at the side are held by iron plates at the bottom, which rest upon brick or tiling. The singeing is done by bent plates of copper heated by an oil flame. A complete singeing plant includes, a singeing house, engine, air compressor, air storage tank, oil tanks and an exhaust blower.

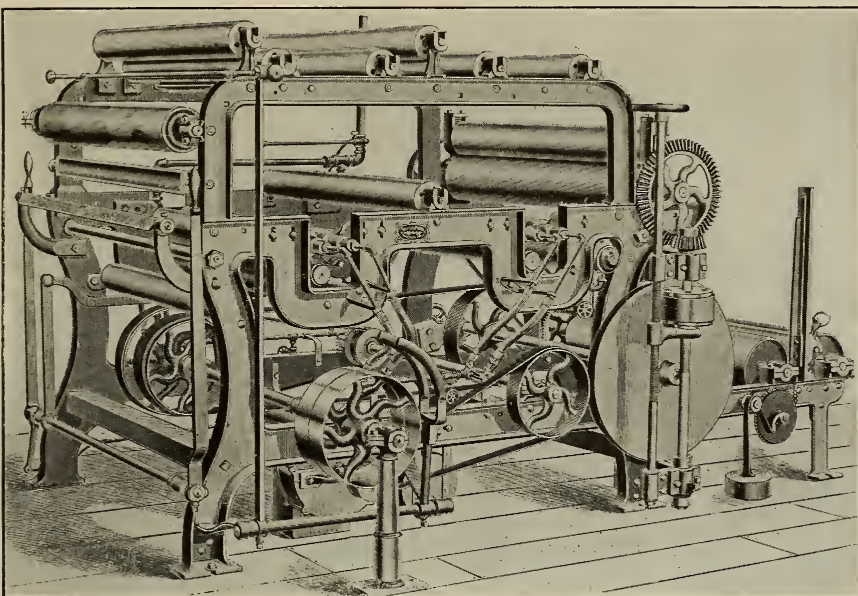


FIG. 79.—THE CURTIS & MARBLE SINGEING MACHINE.

The Curtis & Marble machine, shown in Fig. 79, is used for goods requiring especially complete treatment. The burners have a continuous slot, which is adjustable to different widths of cloth. Brass slides also shorten the flame as may be necessary. The rollers for the passage of the fabric are so arranged that the flame comes against the cloth twice. The passage of the cloth may be arranged to singe either side alone or both sides at one process. The gas is mingled with air in such proportion as to give the maximum heat and complete combustion. The means by which this is done is a fan blower and air reservoir connecting with the gas pipes. The burners check the levers so that the machine cannot be stopped without turning off the flame. The brass rolls over which the cloth passes are kept cool by passing water through them. Various attachments are made for regulating speed, for cleansing the goods as they come from the singeing house and for delivering the finished cloth either in rolls or in folds.

THE HEATH VERTICAL BRUSHER.

Fig. 80 shows the Heath vertical brushing machine for removing lint and dirt from cotton and other fabrics. It is made with three brushes for each side of the fabric, although other cleaning appliances such as emery rolls, sand rolls, card rolls or steel bladed beaters may be used in place of part of the brushes. The fabric passes vertically upward from the bottom to the top of the machine, guide bars being

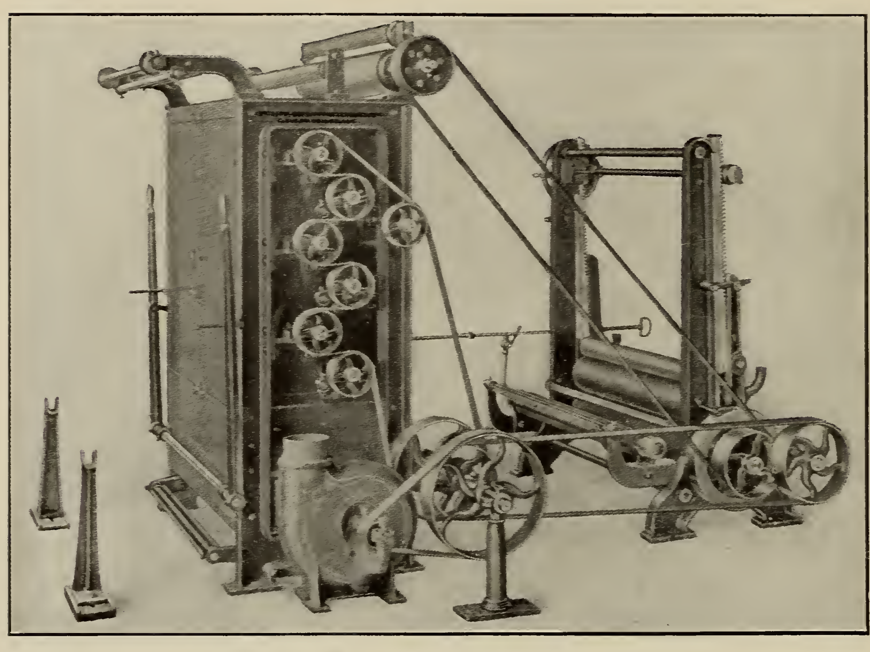


FIG. 80.—THE HEATH VERTICAL BRUSHER.

employed to hold it in contact with the brushes and to prevent vibration. On the interior are dust chutes, through which the dust and lint pass to the bottom of the machine. At the bottom is a hopper with a pipe connected to an exhaust fan to carry away the dust. The brushes have stiff bristles, for cleaning cotton goods, while for more delicate fabrics, such as silks, soft bristles are used. The brushes run in adjustable boxes and may be set to bear heavily or lightly against the fabric. Hinged doors at the front and rear give access to the interior. The machine is made with tension and spreader bars and with draft roll for drawing the cloth through. The illustration shows the machine running in connection with a calender roller at the rear for smoothing out the fabric and putting it up in firm, hard rolls.

Cloth Inspector.

Cloth inspection for knots and faults is necessary before coating certain classes of fabric. The inspecting machine, shown in Fig. 81, is for this purpose. It has a cloth cradle with wooden rolls to hold a roll of fabric up to 18 inches in diameter. Where the cloth comes in larger rolls it is placed on stands. The cloth passes up the inclined

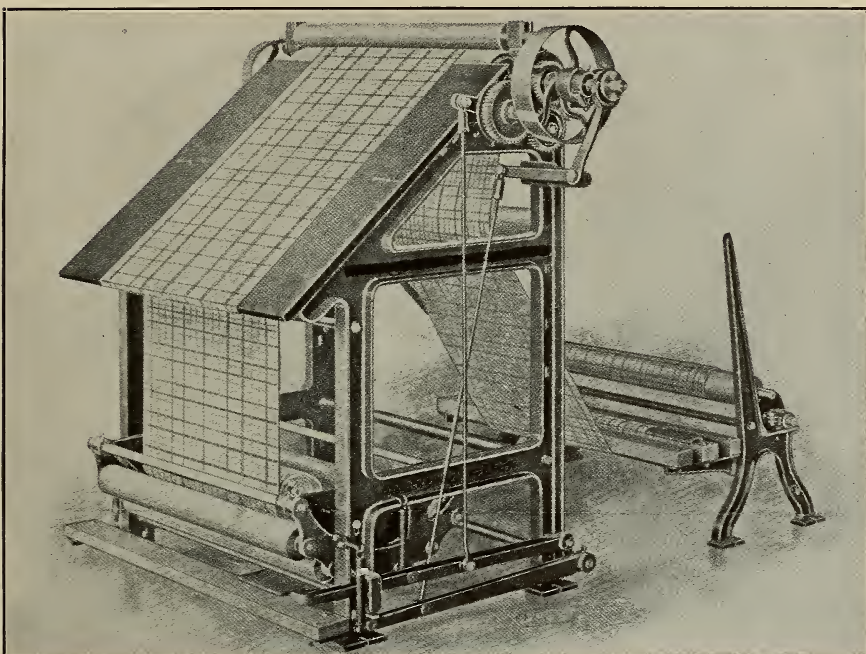


Fig. 81.—Cloth Inspector.

table in full view of the operator and any defects are easily observed. A rolling head at the rear, which winds up the fabric, has spreader bars to remove wrinkles and turned edges. The fabric is stopped and started by the pressure of a foot lever. There is also a reverse motion by which the goods are run backwards. These machines are built in widths from 30 to 108 inches wide.

Railway Sewing Machine.

For sewing ends of piece goods together a railway sewing machine is a great convenience. See Fig. 82. Before being sewed the cloth is drawn out to its full width and held smooth and straight by steel pins on

the machine. The sewing head then travels across the machine, the fabric remaining stationary, and the ends are sewed together with a continuous chain-stitch. The sewing may be done close to the ends, causing very little waste in headings, and the stitches are easily drawn out when desired. The machine is adjustable for different widths of

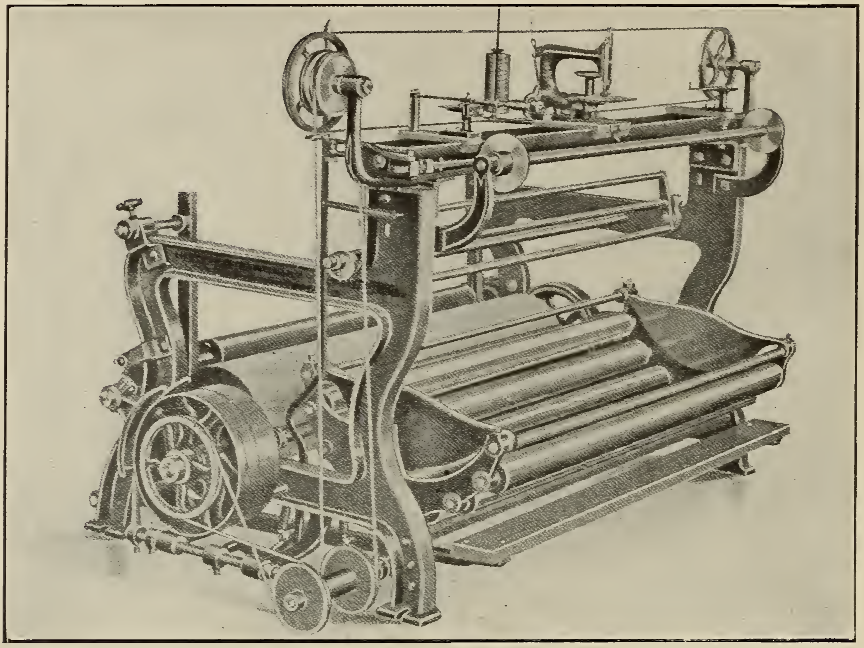


FIG. 82.—RAILWAY SEWING MACHINE.

fabric and the machine head stops automatically at the end of each seam. As soon as one seam is finished a small hand wheel is turned and the sewing head is drawn back to the starting point ready for the next seam. The operator controls the starting and stopping of the machine by a treadle board at the front. A measuring attachment can be added to the machine for registering the length of goods as it is rolled up.

CHAPTER VI.

CALENDERS.

A VERY necessary preliminary to the making up of India rubber goods is getting the rubber into sheet form. Where the compound comes from the mixers in the form of a dry dough this is done by machines known as calenders. The calender consists of two heavy frames in which run two or more steam-heated rolls. These rolls lie horizontally one above the other and the warmed rubber forced between their smooth surfaces is spread into sheets.

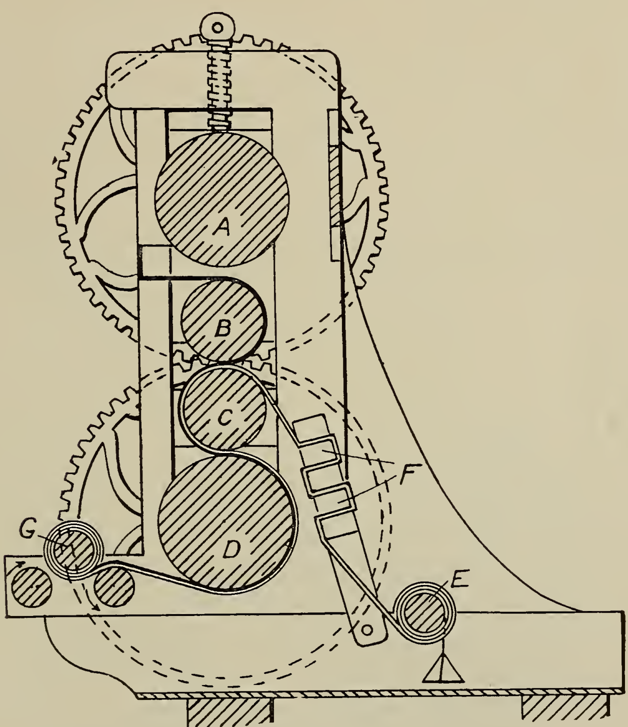


FIG. 83.—THE CHAFFEE CALENDER.

Calendering is not an exact science. A boss calender man who is familiar with a certain line of stocks can get the heat of the rolls just right, can see to it that the compounded stock comes from the warmer at the proper temperature and can sheet the stock smoothly, of the

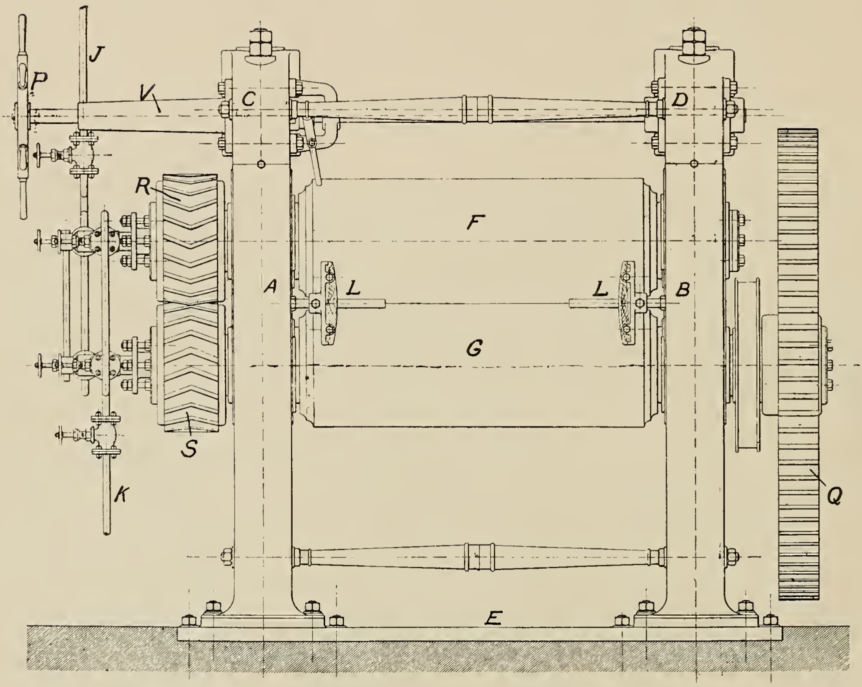


FIG. 84.—TWO-ROLL CALENDER.

proper thickness and without blisters. He is obliged to learn new stocks, however, by experiment. This means that yards of stock are scrapped and warmed again, a loss of time and a detriment to the stock. Moreover, if stock badly run is passed through to the wind-up, it will be rejected by the cutters and come back to the mill room as scrap. This is often so softened that it cannot be used for the purpose first intended, hence another loss.

The calenders shown in this chapter are such as are used in a variety of lines of rubber manufacture. Special types used only in individual lines, such as tires, footwear, etc., will be found in the chapters devoted to such industries.

The first calender, shown in Fig. 83, was invented by Edwin M. Chaffee and differs very little in principle from the machines manufactured today. It had four steam-heated rolls, *A, B, C* and *D*. Rolls *A* and *D* were 18 inches in diameter while the other two were each 12 inches in diameter. Roll *B* was geared to move much slower than the others, providing friction between *A* and *B,* and also

B and C. Where it was desired to use only the three lower rolls the upper one was disengaged and the cloth passed into the machine between B and C. This cloth on a roller E was passed around a number of bars F to provide tension. The rubber was fed between A and B, passing around B and coming into contact with the cloth between B and C where it was pressed into the fabric. The double sheet then passed around C and D and was wound up on a roller G. For colored goods the rubber was sometimes run into sheets and the coloring material applied, after which it was rolled into a compact mass and passed between the rolls repeatedly until thoroughly mixed. In other words, the calender was used as a mixer. This machine was known as the "Monster," so large did it appear to the mechanics of that day.

Two-Roll Calender.

The simplest form of calender is the two-roll. It is not generally used in the United States but in Europe is quite common. It is used sometimes as a doubler and sometimes for sheeting, for "slabbing" and

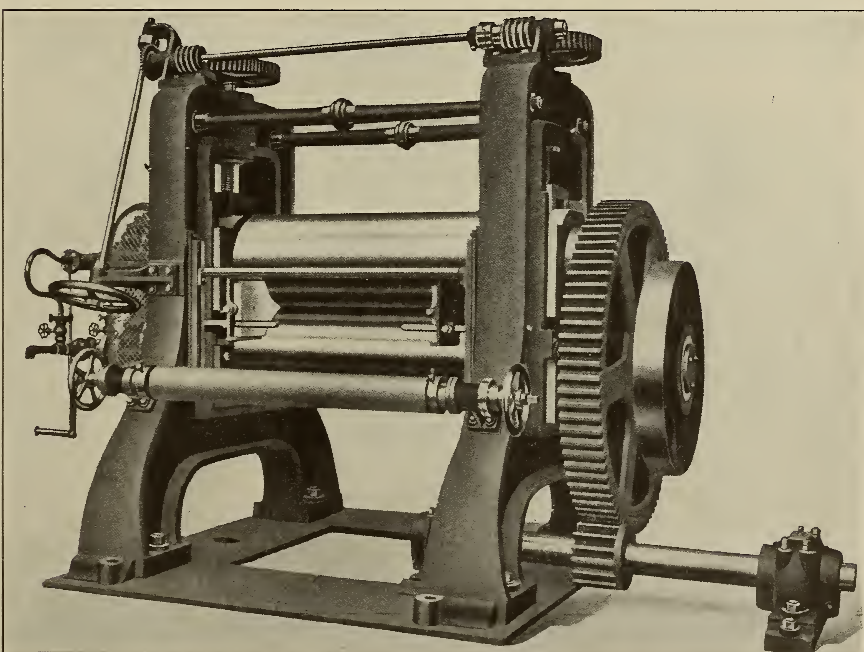


Fig. 85.—Two-Roll Calender.

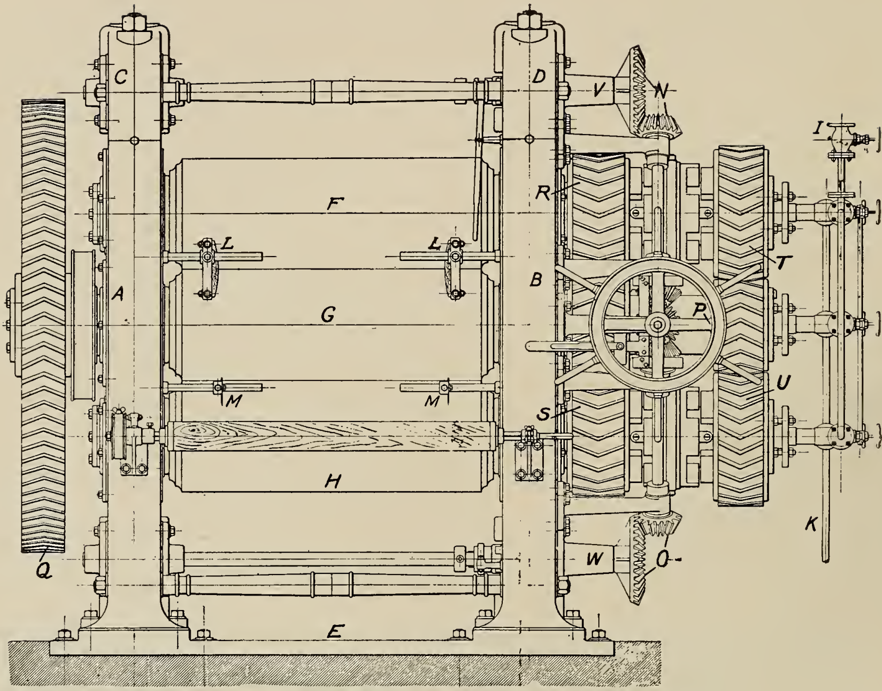


Fig. 86.—Three-Roll Calender—European Type.

for belting. This machine is similar in construction to the three-roll calender described in detail later.

As shown in Fig. 84, it has the frames *A* and *B,* with housings *C* and *D* at the top. The frames are connected at the top and bottom by strong braces, and rest on a foundation plate *E*. The upper roll *F* is adjusted vertically by the hand wheel *P,* while the lower roll *G* is mounted in stationary bearings. The rolls are hollow and provided with steam and water connections *J* and *K*. The machine is driven by the spur gear *Q,* the rolls being geared together by double helical gears *R* and *S*. The adjustable guides *L* govern the width of the sheet.

Three-Roll Calender.

The three-roll calender is the most generally used of all. It is sometimes geared for even motion, sometimes for friction but usually for both. The foundation, frames and drive are practically the same as in the two-roll calender. The middle roll is the drive roll. The top and bottom rolls are adjustable by screws bearing against the

journal boxes. These screws are operated by worm gears and a hand wheel. There are sliding clutches on the worm shafts which allow for aligning the rolls. The rolls are chambered for water or steam and have stuffing boxes with goose necks that connect with steam and water pipes and an exhaust pipe to carry off the condensation.

The drive roll has a friction pinion on the opposite end from the drive gear and the top and bottom rolls are driven from this pinion

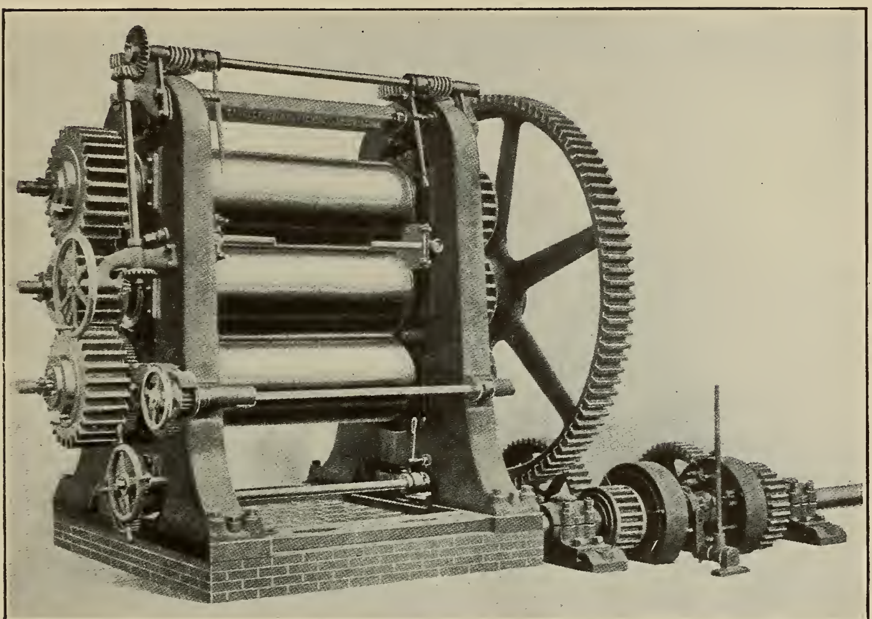


FIG. 87.—THREE-ROLL CALENDER.

with suitable gears to give a surface friction of 1¾ to 1. There are two speeds to drive the gear, one to secure a speed on the bottom roll of about 15 yards a minute, the other a speed of 25 yards a minute.

In front of the calender is a friction let-off attached to the frame of the machine. This is constructed to hold a roll of cloth with more or less tension. On the opposite side of the calender is the wind-up, driven by spur gears or sprocket chain. By means of the friction discs as the roll of cloth increases on the wind-up arbor, the tension slips enough to make up for it. There is also in front of the calender a corrugated spiral spreader roll to take wrinkles out of the cloth and a heated roll to warm the cloth.

The operation of the machine is as follows: The clutch is thrown into the low speed, which starts the machine. Steam is turned into the rolls to warm them up. A batch of warmed compounded stock is placed between the top roll and middle roll forming a sheet of the required thickness entirely around it. A roll of cloth is then placed

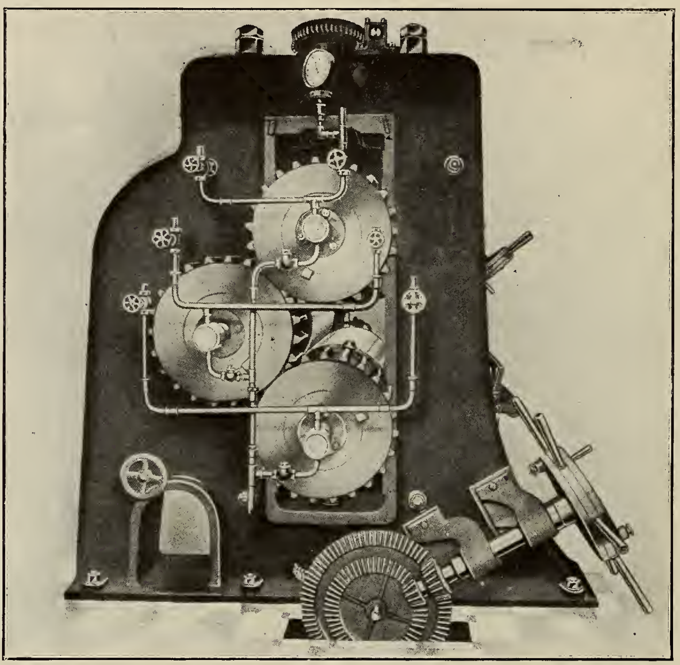


FIG. 88.—THREE-ROLL TRIANGLE CALENDER.

in the friction let-off, the end passed over the spreader roller over the heating roll and through the calender between the middle roll and bottom rolls and attached to the wind-up roller. The machine can be thrown into high speed. It requires about 30 horse-power to run this machine.

The machines illustrated in Figs. 86 and 87 show views of three-roll calenders. The heavy cast iron frames *A* and *B* carry housings *C* and *D* at the top, and rest on a cast iron foundation plate *E*. The frames and housings are connected by strong cross braces. The three hollow, chilled steel rolls *F*, *G* and *H* are piped for steam and water. The steam and water inlet is shown at *I*, with the outlet at *K*. The rolls are mounted in bearings of phosphor-bronze with ring lubricators. Attached to the frame are adjustable guides, *L* and *M*, to

control of the width of the sheet of rubber. The upper and lower rolls are adjusted by vertical screws which obtain their motion from worms on the shafts *V* and *W*, and from the bevel gears *N* and *O* through the action of the hand wheel *P*. By a clutch either the friction or the even gears are thrown in or out of engagement. The even gears *R* and *S*, as well as the friction gears *T* and *U*, are arranged on the same side of this machine. As a rule they are placed on opposite sides.

Standard Four-Roll Calender.

Fig. 89 illustrates a four-roll calender. The second roll from the bottom is the drive roll. The top and bottom rolls are adjustable by

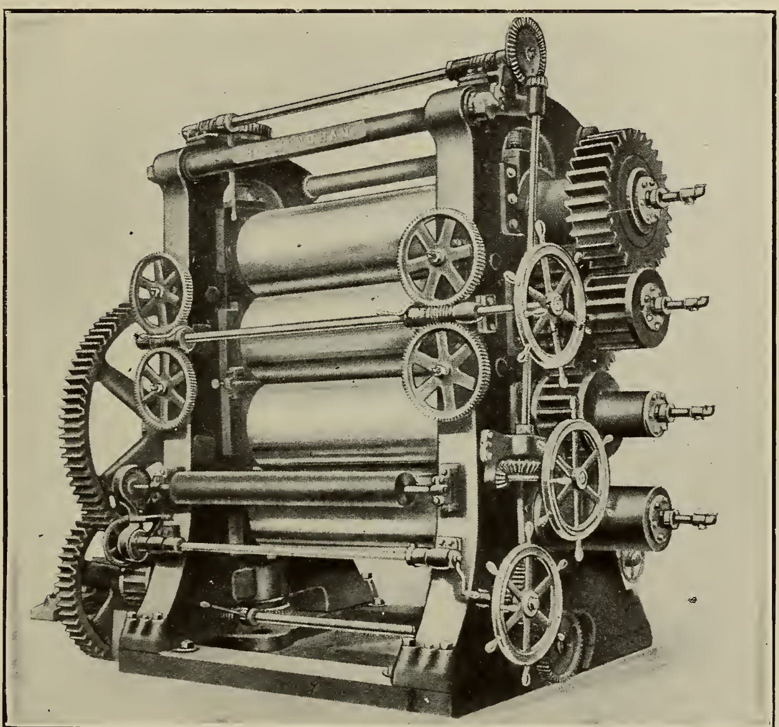


Fig. 89.—Four-Roll Calender—American Type.

screws and worm gearing. The third or next to the top roll is adjustable by wedges above and below the journal boxes, by means of screws and worm gearing.

In American practice the rolls are geared so that the three lower rolls have even motion, and the three upper, friction motion. In European practice all four rolls are geared for both even and friction motion. The friction speed is about 1½ to 1.

The operation of the machine in coating is as follows: The rolls are warmed to the proper temperature. A roll of cloth is placed in bearings in front of the calender. The clutch is then thrown in, which puts the rolls in motion. A quantity of compounded stock from the warming mill is placed between the top and third rolls between

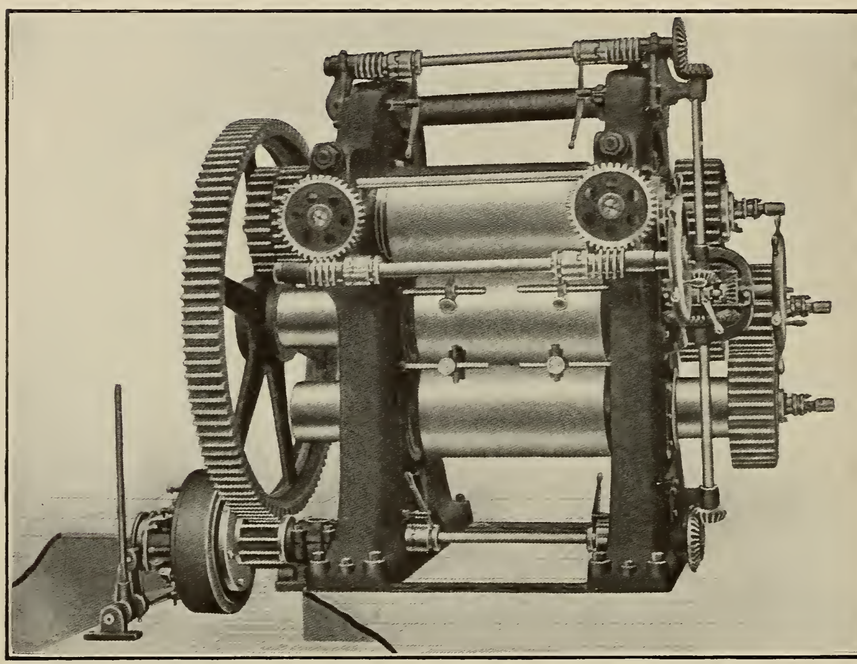


FIG. 90.—FOUR-ROLL ENGRAVING CALENDER.

guides set to the proper width. This forms into a sheet around the third roll and the second roll where it is applied to the fabric. In some factories the coated fabric is wound upon drums which are sometimes 10 or 12 feet in diameter, as this facilitates the later handling. It is a good idea to have a coating calender arranged for at least two speeds as some fabrics can be coated at double the speed of others. A good standard would be 10 yards a minute for slow speed and 20 yards for fast speed. About forty horse-power is required to run the machine described.

The Matthew Calender.

This is a small even motion or friction calender built particularly for making strips, piping, bindings, etc. As shown in Fig. 91, the rolls *A, B* and *C* extend outside of the frame *D* while the reducing gears are placed between them. The rolls are driven at even speed

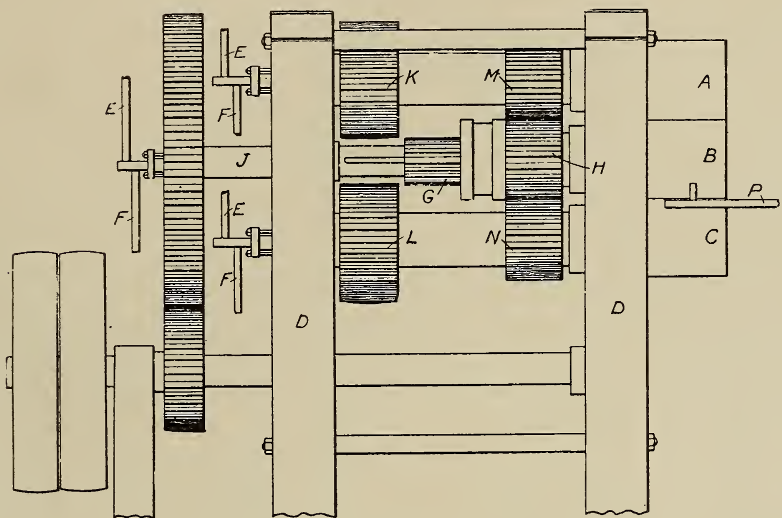


Fig. 91.—The Matthew Calender.

or friction speed, as required, by the pinions *G* and *H* on the shaft *J*. Beside the rolls is placed a table *P*, over which the fabric is led. An adjustable guide is provided between the rolls *B* and *C*, so that the desired marginal width of rubber coating may be applied.

The Steinharter Coating Calender.

It is sometimes necessary to coat leather with rubber, and that is what Steinharter's machine is designed to accomplish. Referring to the diagram in Fig. 92, which shows the machine in section, the sheet of leather *A* passes over a guide *B* and under a wire brush *C*, which revolves at high speed and raises a nap on the surface of the leather. The leather then passes between two rolls *D* and *E*, one of which is heated to a temperature of 100 degrees F., and the other to 300 degrees. Directly above these rolls is a spout *F* leading from a tank containing a thin solution of rubber *G*. This is spread evenly over the surface of

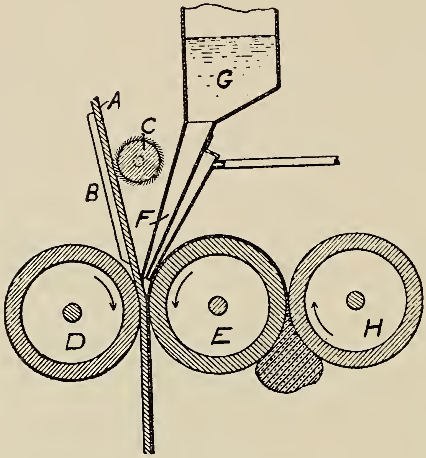


Fig. 92.—The Steinharter Leather Coating Calender.

the leather and acts as a binder. The rubber is fed between the rolls *E* and *H* forming a thin sheet. This is calendered to the leather between the rolls *D* and *E*.

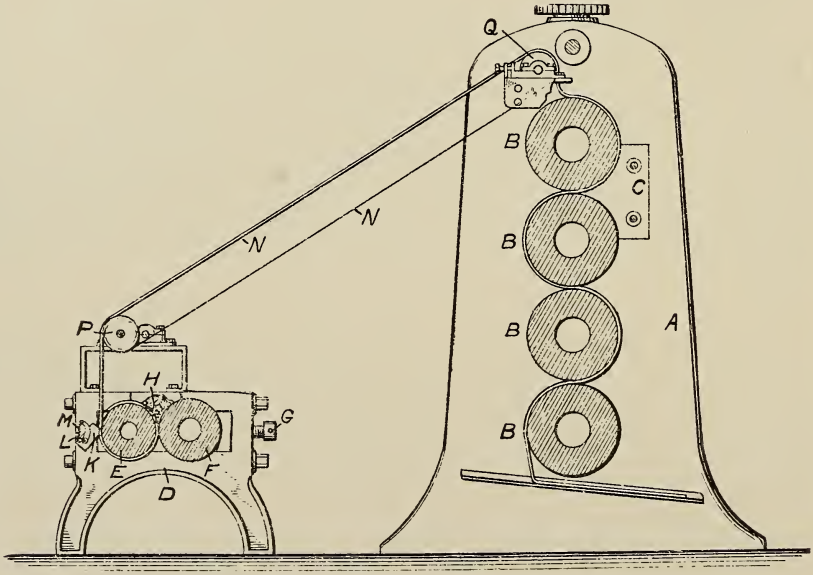


Fig. 93.—The Ackerman Calender Feed.

The Ackerman Calender Feed.

In Fig. 93 is shown a calender feed which is in brief an endless belt carrier that delivers the rubber compound from the warmer to the calender, that exactly the right amount of rubber be thus delivered. The warmer sheets the rubber in the proper thickness and trims the edges of the sheet.

The endless belt delivers the sheet over the top roll of the calender between the top and third roll where ordinary guides are provided, and so on to take off at the bottom. By using a number of knives in connection with the warmer, the sheet is delivered in the form of strips which are simultaneously calendered. *A* is an ordinary four-roll calender. *D* is the warmer. After passing around the roll *E* the sheet is trimmed by knives *K* placed on the horizontal shaft *L*. By means of set-screws the knives may be placed any distance apart. The sheet is carried by the endless pass belt *N* mounted on rolls *P* and *Q* driven by gearing from the main driving shaft. This belt is as wide as the calender rolls *B*. By a proper separation of the rolls *E* and *F* and of the

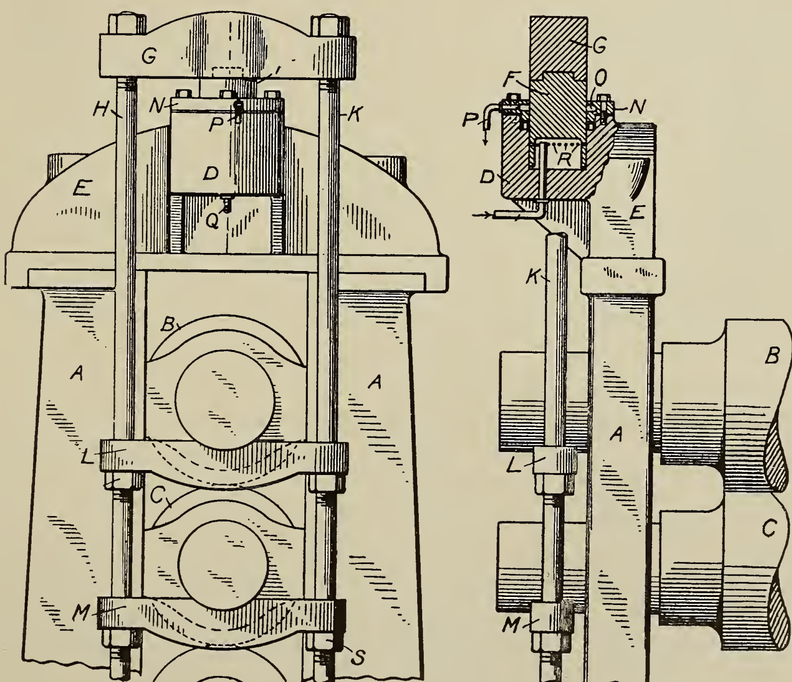


Fig. 94.—The Whitlock Hydraulic Lift.

first pair of calender rolls, the thickness of the sheet is such that it passes without distortion between the calender rolls.

The Whitlock Hydraulic Lift.

Fig. 94 shows a lift (used so far for paper calenders only) operated by hydraulic cylinders placed at the top of each frame of the calender. In the illustration only one cylinder is shown. The frame *A*, containing two or more rolls has a hydraulic cylinder *D* cast integrally with cross piece *E*. The plunger *F* acts directly against the yoke *G* on which are two threaded rods *H* and *K*, which support yokes *L* and *M* which bear the ends of the rolls *B* and *C*. The cylinder is provided with a packing ring *N* and in which is cut a circular groove *O* to allow the water to pass from the cylinder through holes *R*, to the overflow pipe *P* when the plunger is at the top of its travel.

The Beswick Electrically Heated Roll.

The calender roll shown in Fig. 95 is heated by electricity instead of by steam. In the illustration, *A* represents a portion of the frame

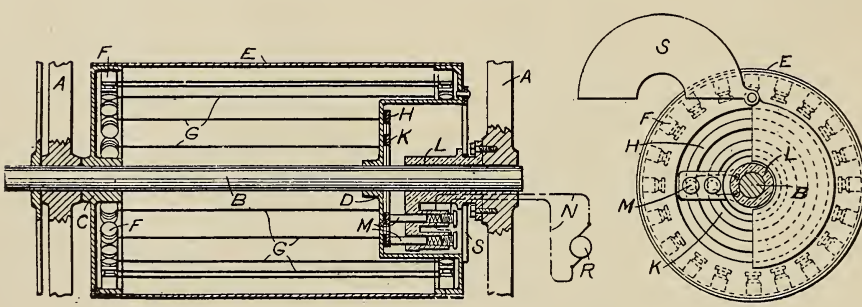


Fig. 95.—The Beswick Electrically Heated Roll.

of the calender, in which is mounted the shaft *B*. The heads *C* and *D* are mounted on this shaft and bear the roll *E*. Secured to the interior of *C* and *D* are electric insulators *F* which carry the iron wires *G*. These wires are arranged to follow the contour of roll *E*. On the outer surface of *D* are insulated conducting rings *H* and *K* connected with wires *G*. Attached to the frame *A* are insulated brush holders *L* carrying carbon brushes *M*. These brushes may be connected through *N* to the source of electrical energy *R*. The outer end of the roll beyond the head *D* is enclosed by swinging doors *S*, which permit access to the brushes.

The Hadfield Calender Feed.

Hadfield's machine for carrying compounded stock from the warmer to the calender, keeping it warm, and incidentally dispensing with the service of one calender tender, is shown in plan view in Fig. 96. At *A* is shown a main frame upon which are mounted four calender rolls. The shaft *H* is provided with a guide roller *I* and a sprocket *J*, the latter transmitting motion to the feed rollers *U*. The shaft *K*

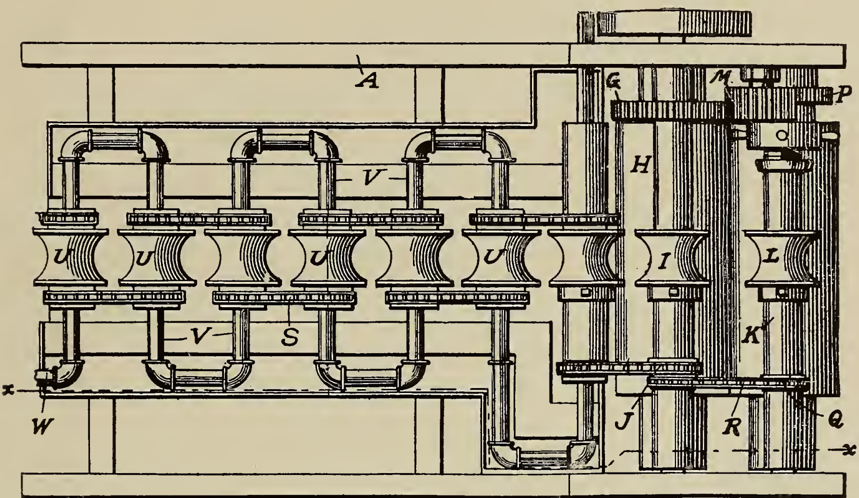


Fig. 96.—The Hadfield Calender Feed.

carries another guide roller *L* and a gear *P* which meshes with the idler gear *M*. Thus, when power is applied to the driving pulley, the rollers *U* are driven by sprocket chains *Q, R, S,* etc. The conveyor rollers rotate upon steam pipes *W* and *V* which supply heat to them. From the warmer the rubber, in rolls about three feet long and five inches in diameter, is placed on the feed rolls *U* and delivered to the calender.

The Dootson Roll Lubricator.

Fig. 97 shows an end section of a calender roll equipped with Dootson's lubricating bearing. This consists of bearing sections *A* between which are metal boxes *B*. The side next to the roll neck *C* is made of metal gauze *D*. The box is filled with heavy grease and feeds through the gauze. Each box is lined with asbestos *F* to keep the lubricant from liquifying and has a door *E* for filling.

The Claremont Calender Gage.

Fig. 98 shows a novel form of gage for measuring thickness of sheets of rubber on the calender. *A* is a cylinder containing a rubber bag

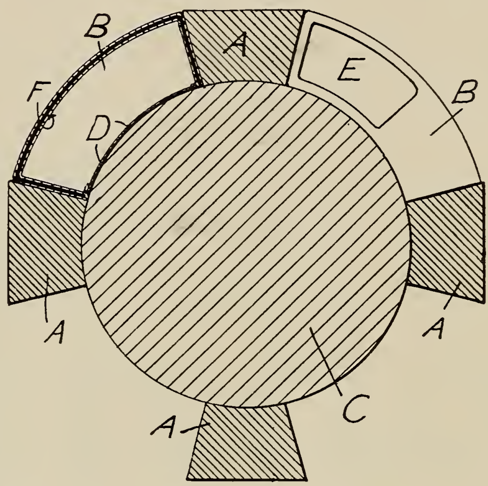


Fig. 97.—The Dootson Roll Lubricator.

B. On each side of *B* is a piston, one of which is attached on roller *C*, the other to an adjusting screw *E*. From the bag *B* a graduated glass tube *F* projects above the cylinder. The sheet to be measured passes between the calender roll and the roller *C*, the liquid in *F*, being set at zero by the screw *E*. As the sheet comes against the roller the piston

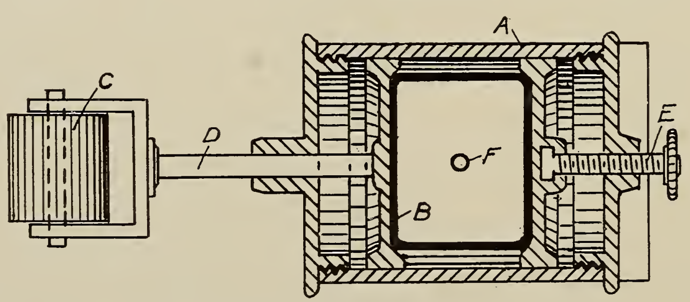


Fig. 98.—The Claremont Calender Gage.

compresses the liquid in the cylinder and forces it up in the tube. The apparatus is very sensitive and a slight variation in the thickness of the sheet is accurately recorded in the tube by the change in the height of the liquid.

The Coulter Spreader Bar.

The device shown in Fig. 99 is an angle or V-shaped spreader bar applied to calender rolls. Its office is to spread the rubber before being run into a sheet between the rolls. The drawing shows a sectional view looking toward the ends of the rolls *A*, *B* and *C*. The face of each spreader bar *D* conforms to the periphery of the rolls and the spaces *K* between them and the rolls are adjusted by the hand wheels *E*.

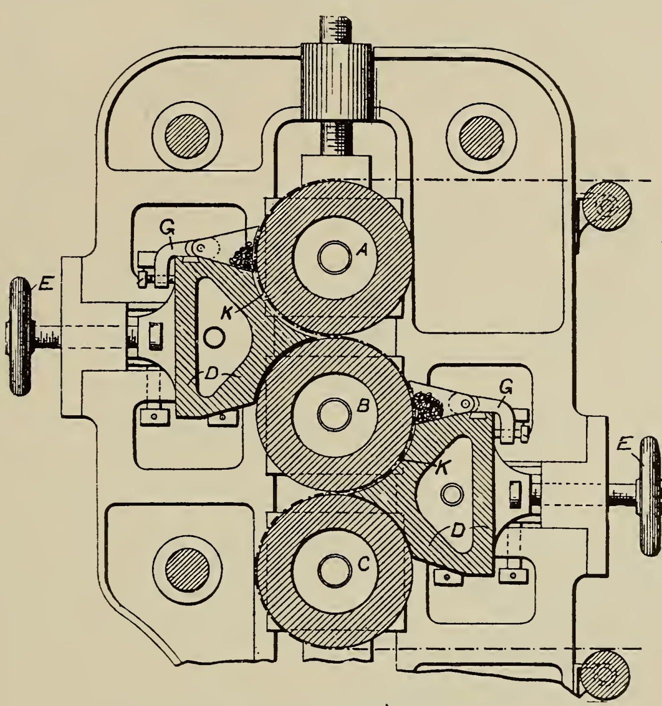


Fig. 99.—The Coulter Spreader Bar.

The spreader bars are hollow, to allow them to be heated or cooled. To control the width of the sheet, adjustable width-gages *G* are mounted in dovetailed slots at each end of *D*.

Separate Wind-Up Cooling Roll.

It is often desirable to wind up the coated fabric as it comes from the calender, by means of a separate roller set a short distance away, instead of on the wind-up roller usually fixed to the calender frame. The stand shown in Fig. 100 is designed for this purpose. It is equipped with a cooling roll *A* and stretcher *E* set on cast

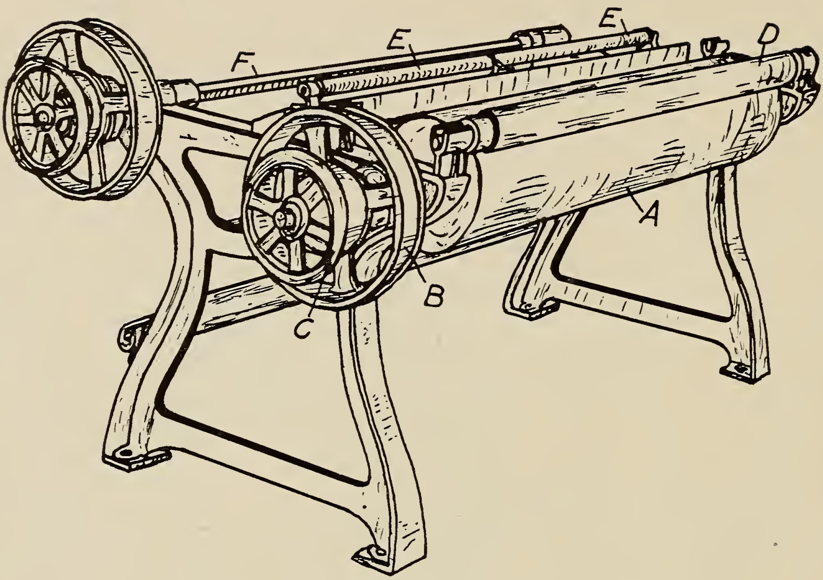


Fig. 100.—Separate Wind-Up Cooling Roll.

iron frames. The cooling roll is a seamless brass tube 12 inches in diameter, with cast iron heads and water connections. The roll is driven by a flanged friction pulley *B*. By the hand wheel *C*, the roll can be adjusted to give the proper amount of slip. Above the cooling roll are two wooden rollers *D* (only one being shown) for passing the fabric over the cooling surface. The stretcher *E* consists of two rollers set at such an angle to each other that they remove the wrinkles from the fabric as it is wound.

Gammeter Stock Shell.

The Gammeter stock shell shown in Fig. 101 is a metal roller for winding up stock as it comes from the calender. It is made with thin steel walls and is open at the ends so that air may circulate through it. The shell *A* is riveted to iron supporting rings *B*, the end rings having square openings in the hubs for the mandrel. A square tube *C* connects the two end frames so that the mandrel may be easily slipped through from one end to the other. A slot *D* extends along one side of the shell, into which a metallic strip is slipped. Attached to this is a fabric apron *E*, extending almost around the shell and used for holding the end of the calendered sheet when starting to wind it up. One complete revolution of the shell causes the apron to close down upon the stock, thus permitting tension to be applied to wind smoothly and without slipping.

THE BOWEN ROLL GRINDER.

Figs. 102 and 103 show a somewhat complicated machine for grinding calender rolls with straight or crowned surfaces. It has two grinding wheels located on opposite sides of the machine frame so that both sides of the roll are worked upon simultaneously. The roll with

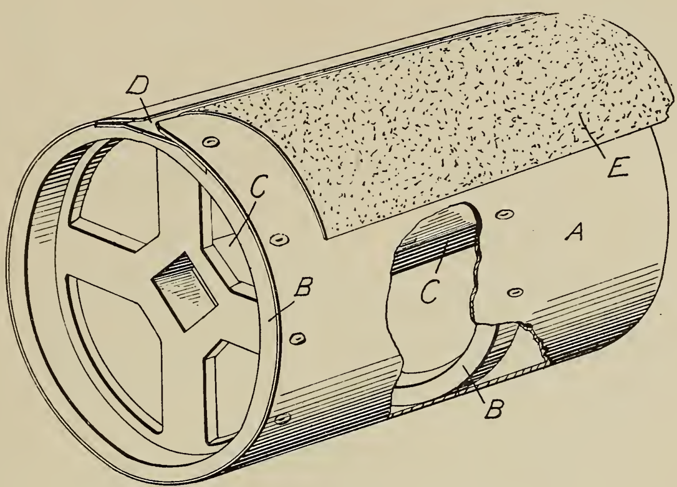


FIG. 101.—GAMMETER STOCK SHELL.

its journals is placed in the bearings *A*, the end being fastened to the coupling head *B* of the driving shaft *C*, which is driven by the pulley *D*. The emery wheels *E* move horizontally along the face of the roll on the

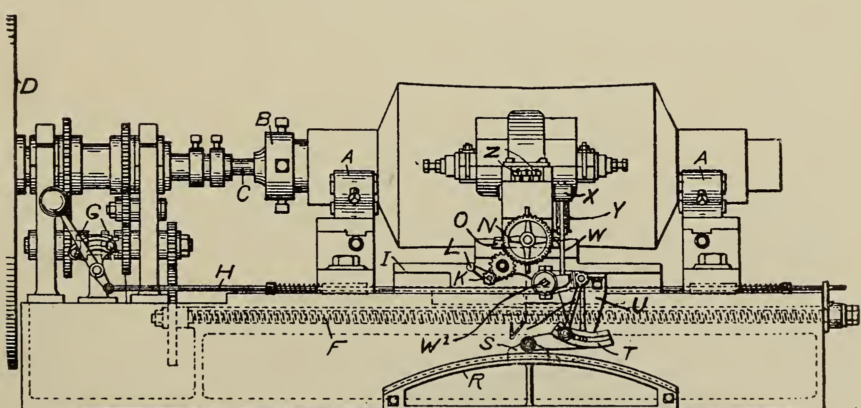


FIG. 102.—THE BOWEN ROLL GRINDER.

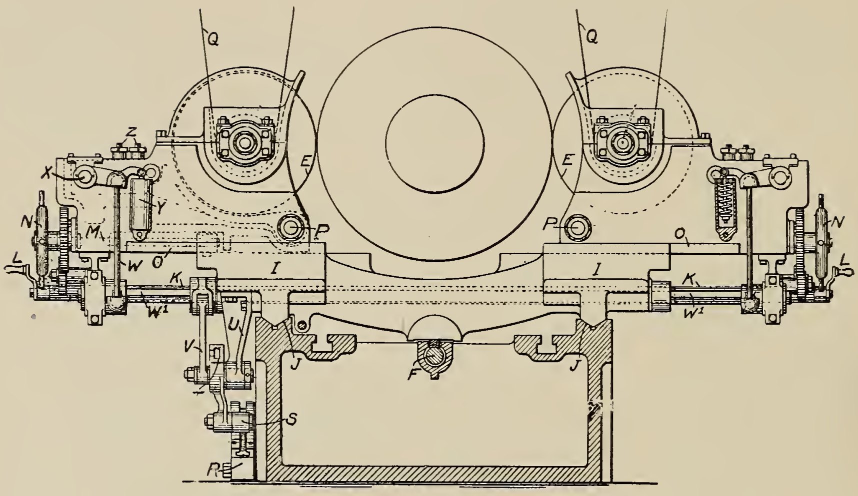


Fig. 103.—Section Through the Bowen Roll Grinder.

screw shaft *F*. This is accomplished automatically as the grinder reaches the end of the roll, through a lever and a spring controlled rod *H* connected with the clutch quadrant. In the end view of the machine it will be seen that the grinder carriage *I I* is arranged to slide in grooves *J J* in the bed. Running through this carriage, from one side to the other of the machine, is a shaft *K* which bears a hand crank *L* at each end and is geared to an adjusting screw *M* bearing hand wheels *N*. It is by means of these screws that the plates *O*, upon which the grinding wheels are mounted, move toward or away from the roll. If considerable movement is desired, the screws *M* are turned directly by one of the hand wheels *N*, while for fine adjustment, either of the hand cranks *L* is used. When one screw is turned the other screw on the opposite side of the machine will be turned the same amount and in the same direction, so that the carriers on both sides are simultaneously adjusted.

The holder of each grinding wheel is pivoted on its carriage at *P* and the grinders are driven by belts *Q* from an overhead shaft. This allows them to be moved around the pivots as centers without slackening of the belts. The rod *V* operates a lifting arm *W* and this rotates the crank shaft *X* which raises or lowers the grinder. By setting

the block on the lower end of the rod V on one side of the center of the link T, the grinders will cut a convex surface, while setting on the opposite side will give a concave cut.

The Linton Roll Grinder.

The Linton machine, shown in Fig. 104 grinds calender rolls without taking them out of the frame. A is a shaft upon which the emery wheel B is shown in position. Pulley C is driven by a belt from

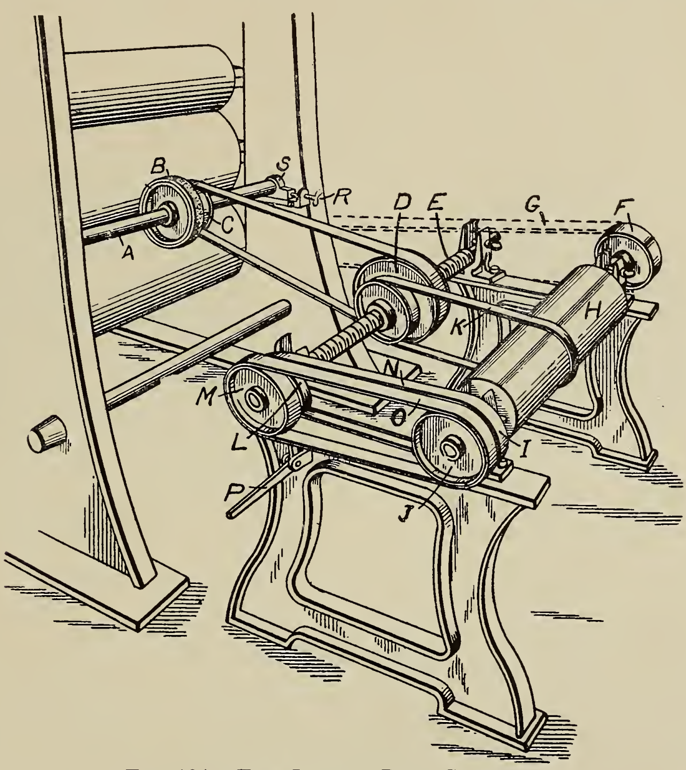


Fig. 104.—The Linton Roll Grinder.

pulley D. This pulley is mounted on a threaded sleeve on the screw shaft E. The appliance is driven through pulley F by the belt G which runs over the neck of the calender roll. This drives the drum H and through the belt K and the pulley D, the emery wheel B. The pulleys I and J drive loose pulleys L and M on the end of the screw shaft E, through belts N and O respectively. These pulleys may be made to drive the screw shaft fast or slow by engaging a clutch through the lever P. A fine or a coarse cut is given by regulating the distance of

the shaft A from the rolls, by means of screws R acting on the adjustable bearing blocks S.

In an earlier machine invented by Linton, the grinding wheel was loosely mounted on a tubular shaft which contained the screw shaft, access to which was through a slot cut the entire length of the tube. A pin in the hub of the grinding wheel engaged the screw through the slot, so that it traveled along the rolls of the calender much as in the machine described above.

CHAPTER VII.

CLUTCHES, DRIVES AND SAFETY STOPS FOR MILLS AND CALENDERS.

The mechanical appliances for stopping and starting mills and calenders broadly known as clutches, are found in great variety and are most important. To operate these instantly in case of accident a great number of safety stops have been invented. When one is on the subject of clutches and safety stops it is natural that the drive, electrical or other, be considered. That brings up the question of variable speed and calender and mixing room arrangement. All of the above topics are reviewed in the following pages.

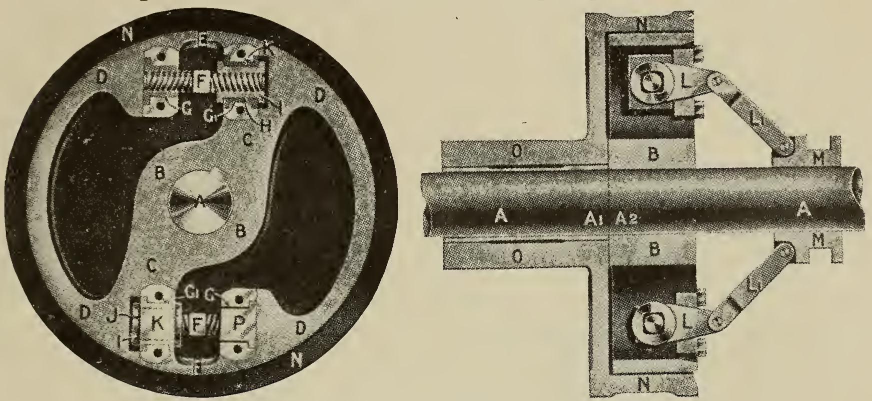


Fig. 105.—The H. & B. Friction Clutch.

In the olden time the form of clutch universally used was the jaw clutch. Today it has been almost wholly superseded by friction and magnetic clutches.

In many rubber mills much of the power exerted in driving the gearing is wasted by the main shafting being kept in motion while a part or all of the machines are at rest. Where individual electric drive is not employed the remedy for this is the adoption of friction clutches located at different points throughout the mill. They not only effect a saving in power but may be the means of avoiding serious accident by permitting prompt stopping of the main shaft or of individual machines.

The H. & B. Friction Clutch.

A friction clutch for driving calenders and grinders is shown in Fig. 105. *A* is the driving shaft. *B, C* and *D* are inner integral parts

of the clutch, keyed to the shaft *A* and revolving with it. On the left is shown the rim *D* split at *E* and *E*, and right and left hand screws *F F* which are connected by levers *L L* to the sliding sleeve *M*. The outer casing *N* and the hub *O* of the clutch are integral and revolve on the shaft *A*.

In operation, the part *B*, the levers *L* and the sliding sleeve *M* revolve with the shaft *A*. The casing *N*, *O*, is keyed to the gear or pulley of the machine to be driven and is loose on the shaft *A*. The clutch is operated by a lever which forces the sliding sleeve *M* toward the clutch. The levers *L L* turn the right and left hand screws *F F*, which expand the rim *D* against the inner surface of the casing *N*, causing it to drive the machine.

The Vaughn Friction Clutch.

Fig. 106 shows a multiple-band friction clutch. It is of the balanced coil type. The principal members are two steel coils and a chilled iron drum. The coils are controlled by two semi-circular

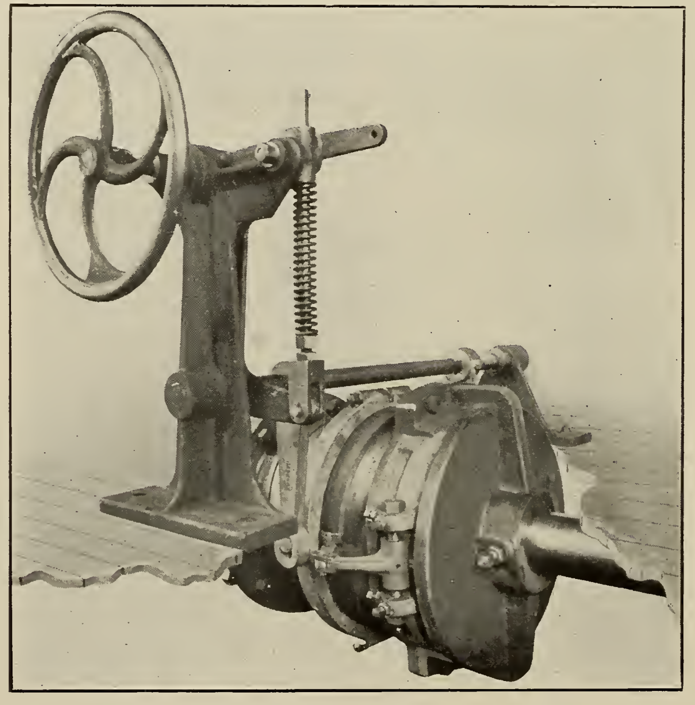


Fig. 106.—The Vaughn Friction Clutch.

shoes which contract on the tail end. When the clutch is in action, the shoes are drawn up to the coil by the toggle.

This clutch provides an effective safety stop, as the coils release from the drum instantly. The comparatively small diameter eliminates momentum, brakes being unnecessary. The toggle action is such that when the clutch is engaged it is locked in position, requiring no pressure to hold it. The handwheel controller is equipped with a safety trip, which is mechanical and positive in action. If desired, it can be operated from push buttons located at convenient points.

The Gordon Pneumatic Clutch.

In Fig. 107 is shown a pneumatic multiple disc clutch connecting two shafts. It consists of a circular casing *A* keyed to the driving shaft *B*. In the casing are twelve friction discs *E* and *F* arranged alternately. Six of these are fastened to the casing *A* and six to the hub which is

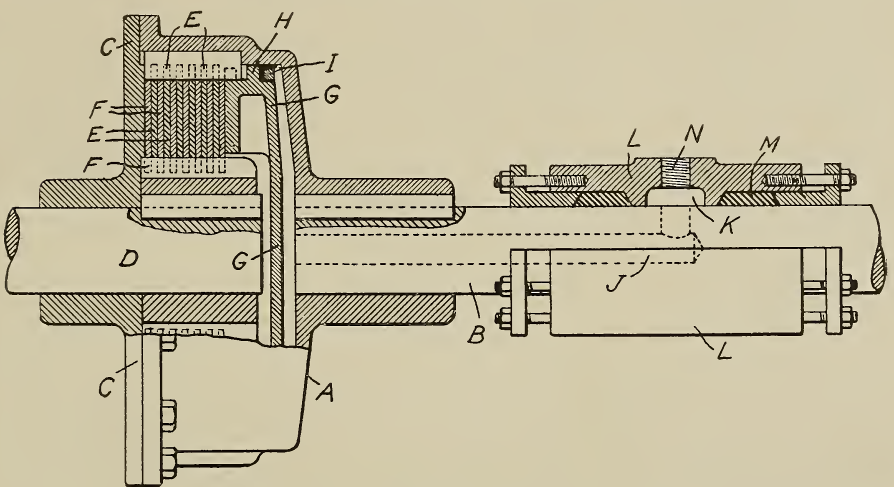


Fig. 107.—The Gordon Pneumatic Clutch.

keyed to the driven shaft *D*. *G* is a circular piston which acts against the discs. *C* is a cover bolted to the casing *A* turning on the shaft *D*. The clutch is operated by air or water under pressure admitted at *N*, passing through the opening *J* and forcing the piston and the discs tightly together. This transmits the motion to the driven shaft.

Magnetic Clutch.

A type of magnetic clutch that not only couples the driving to the driven shaft but also has an automatic brake which acts when the current is interrupted is shown below. One objection to the magnetic

clutch was that the time between the opening of the operating coil circuit and the releasing of the coupling was small and practically negligible under a full load but large under a light load. Another objection was that they did not engage gradually but took hold almost as suddenly as a jaw coupling.

The first objection appears to have been overcome by an automatic band brake on the mill side of the cut-off coupling and the other by the Cutler-Hammer accelerator clutch.

Magnetic Clutch with Automatic Band Brake.

Fig. 108 shows two views of this clutch equipped with an automatic band brake. The driving part of the clutch or field *A* carries the magnetizing coil *B*. It has a hub *D* which is keyed to the driving

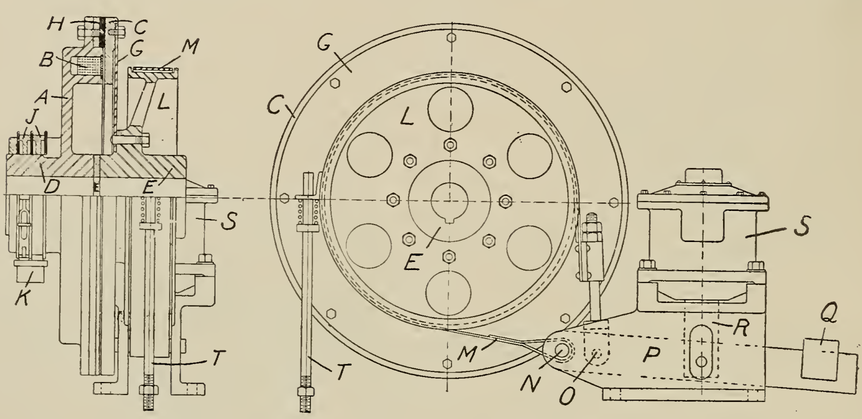


Fig. 108.—Magnetic Clutch with Automatic Band Brake.

shaft. The armature or driven member *C* has a similar hub *E* which is keyed to the driven shaft. Attached to *E* is a flexible spring steel plate *G* which carries the armature *C*. A friction facing *H* prevents the armature from coming directly against the face of the coil and also provides frictional contact for driving. This friction facing is woven asbestos and brass wire similar to brake lining On the hub *D* are two insulated contact rings *J* which are attached to the ends of the magnet winding *B*. This is supplied with current by contact with a pair of brushes *K*, from the source of power. Attached to the driven shaft is a brake drum *L* with a brake band *M* of the same material as the friction facing *H*. The ends of the brake band are pivoted at *N* and *O* to a lever *P*, which carries an adjustable weight *Q* at its outer end. Near the center of this lever is pivoted a vertical rod *R* attached

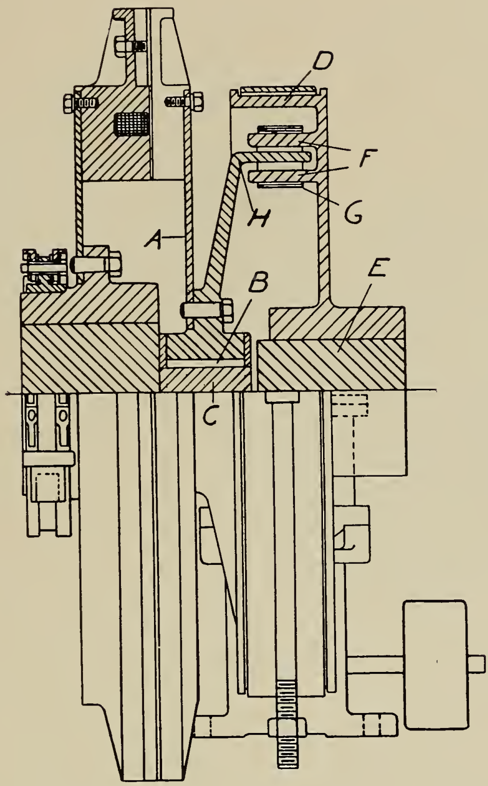


Fig. 109.—Magnetic Clutch and Brake with Flexible Coupling.

to a solenoid in the cylinder *S*. The solenoid raises the lever *P* when the circuit is closed, thus loosening the brake band.

The operation is as follows: The current is gradually applied to the magnet coil by means of a rheostat. As the current increases in the coil the flexible steel plate containing the armature is pulled toward the coil. The friction gradually increases between the armature and the friction facing until the current is strong enough to rotate the driven shaft at the same speed as the driving shaft. The current applied to the magnetic coil energizes the solenoid and lifts the weighted lever allowing the brake drum to run free. Rod *T* serves to hold the brake band in circular form when the brake is released.

In case of accident the switch is thrown by a rod or lever conveniently placed, thus breaking the circuit. This also interrupts the solenoid circuit, allowing the lever *P* to drop and tightening the band around the drum. Thus it will be seen that in addition to shutting

off the power the brake is applied the instant that the two shafts are uncoupled, bringing the mill to a quick stop.

Magnetic Clutch and Brake with Flexible Coupling.

A combination magnetic clutch, brake and flexible coupling is shown in Fig. 109. In this the armature *A* is carried by a roller bearing *B* on an extension *C* of the power shaft. Connection is made between the armature and the brake wheel *D*, which is carried by the mill line shaft *E*, through a flexible coupling. This is a cylindrical extension *F* on the flange carrying the brake wheel. These extensions are slotted and encircled by a rawhide band *G*. A flange *H* projects into the annular slots and serves to transmit the power. This coupling is sufficiently flexible to permit the driving and driven shafts to be out of level as well as out of alignment. The 60-inch clutch has a normal rating of 450 horse-power at a speed of 90 revolutions per minute.

Clutch and Brake Installation.

Fig. 110 shows the installation of the magnetic clutch described above. The shaft of the motor *A* carries the driving member *B*. The

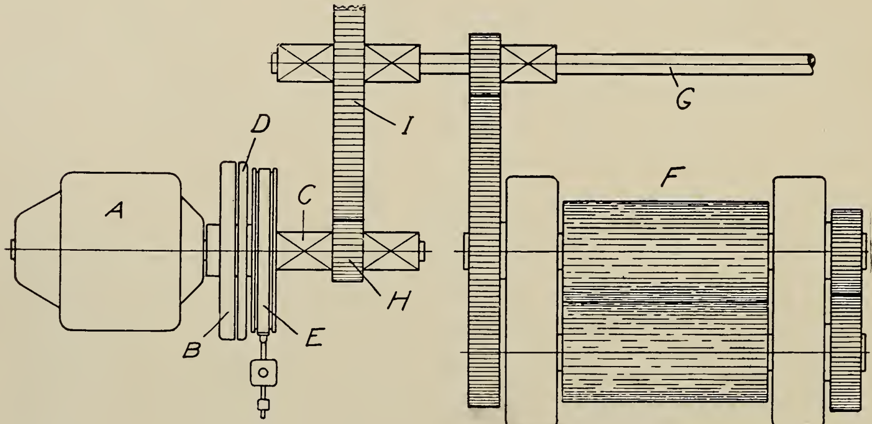


Fig. 110.—Clutch and Brake Installation.

end of the driven shaft *C* carries the armature *D*. When the clutch is disengaged the two shafts are independent of each other. The shaft *C* also carries the automatic brake *E* which is applied when the clutch

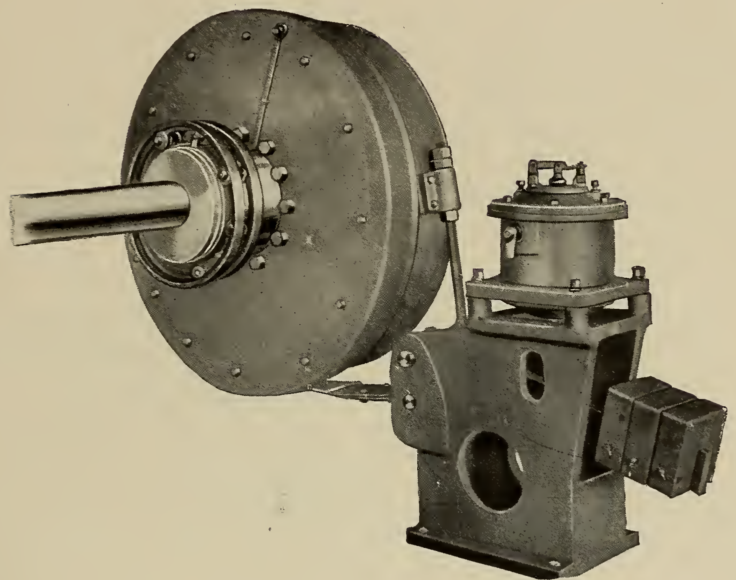


Fig. 111.—Magnetic Clutch and Brake Assembled.

circuit is broken. The mill shown at *F* is driven from the line shaft *G* through the pinion *H* and gear *I*.

Drives for Calenders.

The means for driving calenders may be considered as a separate subject since, by the installation of proper gearing, any method of drive may be employed. Formerly, calenders were driven by steam engines from line shafts, but in recent years this form of drive has been gradually superseded by the electric motor. Usually the speed of the motor is reduced with one pair of gears in addition to the calender driving gear and pinion, but it is sometimes necessary to use two pairs owing to special conditions.

Two-Speed Drive.

In Figs. 112 and 113 are shown a plan and elevation of a two-speed drive with a double friction clutch mounted on the main shaft. The pinions *A* and *B* are mounted on loose sleeves on the driving shaft *C*. The outer casings of the clutches *D* and *E* are also mounted on these sleeves and turn with the pinions. The splined sleeve *F* turns with

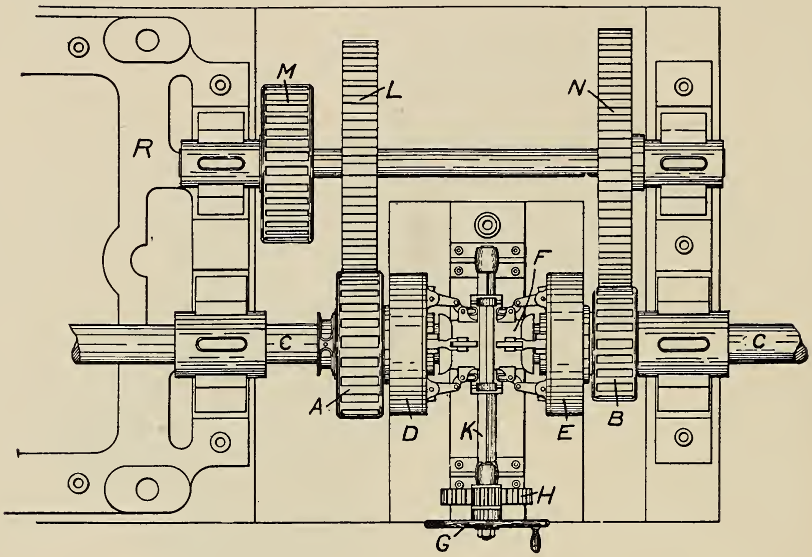


FIG. 112.—TWO-SPEED DRIVE.

the shaft and is moved in either direction by the hand wheel *G,* the segment rack *H* and a yoke on the shaft *K*. By turning the hand wheel *G* to the right, the sleeve *F* moves to the left, engaging the clutch *D*

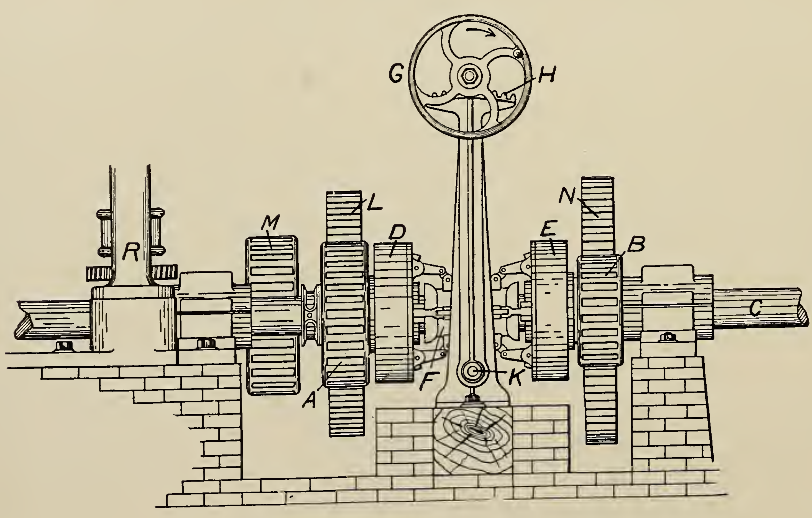


FIG. 113.—ELEVATION OF TWO-SPEED DRIVE.

and driving the pinion A, gear L and pinion M of the machine. Since the pinion A is larger than B, this engagement provides the higher speed. If the lower speed is required, the hand wheel is moved in the opposite direction, engaging the clutch E and the gears B and N.

Three-Speed Drive.

The triple friction clutch drive, in Fig. 114, is one of the methods of obtaining different speeds before the general adoption of electric drives. The driving shaft, which runs at a constant speed, carries

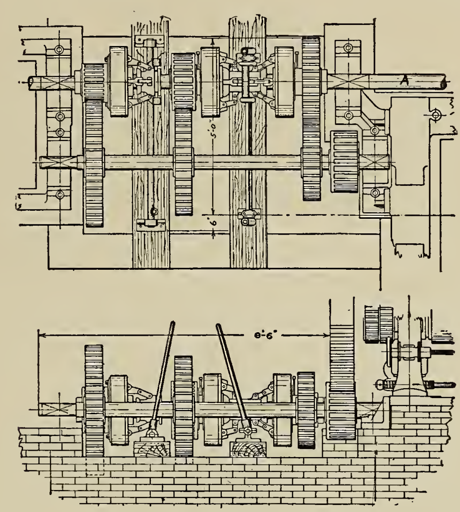


Fig. 114.—Three-Speed Drive.

three friction clutches attached to gears. Each of these gears engages with pinions on the calender driving shaft. These gears and pinions give three speeds and the change from one to another is made by throwing in the proper clutch.

Electric Calender Drive.

Fig. 115 shows a typical electric drive with one pair of reducing gears. The motor A is set on a separate foundation plate B. Its shaft bears the pinion D which engages the large gear E. This is mounted on the shaft F with the calender pinion G. The electric controller for starting and stopping the motor takes the place of a clutch. In the installation shown, the motor is a slow, variable speed type on account of the slow speed of the calender and the small gear reduction. Individual electric drives furnish variable speed controls. With these a calender can be run fast or slow by operating one of several switches.

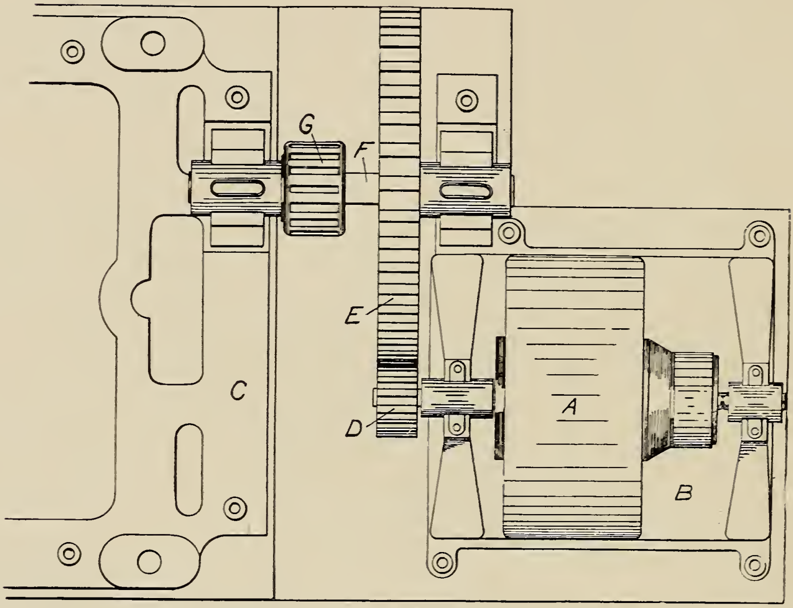


FIG. 115.—ELECTRIC CALENDER DRIVE.

It is estimated that three motor driven calenders will turn out the same amount of work as four calenders driven from a line shaft. This is due to the wider range of speed, the time saved in changing from one speed to another, and the ability to run the calender at the highest practicable speed for each kind of stock. Calenders are driven by either direct or alternating current motors, and such drives for all classes of machines and for all kinds of work have become standardized.

In this connection, what C. A. Kelsey has written is of special interest.

*"The power required to drive a calender varies over a wide range, depending on the character of the compound, thickness, width and speed. The speed is limited to that at which the compound can be run without blistering or the forming of a rough surface. When the calender is started up with cold rolls the permissible speed is higher than after the cooling rolls become heated. As these rolls become heated, it is necessary, in order to obtain the desired surface of the sheet, to

* From "Electrical Requirements of Certain Machines in the Rubber Industry," by C. A. Kelsey—Proceedings of the American Institute of Electrical Engineers, July, 1913.

reduce the speed. A fine speed graduation is therefore necessary to maintain a maximum output. The torque required depends upon the thickness and material and there are so many combinations possible together with the speed requirements that it is difficult to formulate any rule to determine the power. The motor must be large enough to meet the extreme conditions.

"From a number of tests made, it is found that an 18-inch (45.6 cm.) diameter, 40 inch (1 meter) face, three-roll calender running at a surface speed of 37 feet (11.2 m.) per minute, requires an average of 20 h. p. A 24-inch (60 cm.) diameter, 48-inch (1.2 m.) face, three-roll calender running at a surface speed of 35 feet (10.6 m.) per minute requires an average of 35 h. p. and a 22-inch (55.8 cm.) diameter, 65-inch (1.64 m.) face, three-roll calender running at a surface speed of 36 feet (10.9 m.) per minute requires an average of 45 h. p.

"Some compounds that are run through the calender in successive layers which build up to ½-inch (1.27 cm). or even ¾-inch (1.9 cm.) must be run at approximately 20 feet (6 m.) per minute, while for friction work the speed of the driven roll may be 80 feet (24.3 m.) per minute. The thick sheets will require slightly greater torque than the average thickness while the torque for so-called friction work is considerably less.

"As the compound and fabric are fed through in a continuous sheet the power required for a given material, thickness and width is quite uniform.

Motor Characteristics.

"In considering the power and speed requirements of the different machines, it is seen that the mills for working up rubber and mixing it to form the various compounds, call for extreme overloads, but of short duration. By grouping these mills and driving by a single motor the load peaks can be reduced. Instead of the maximum values being 200 per cent. of the average, it has been determined that this can be reduced to 150 per cent by driving with one motor a group of six mills used for masticating, mixing and warming.

"Where individual drive is used, alternating-current polyphase squirrel cage motors are best suited to carry the high load peaks. By grouping the mills, a motor of smaller capacity than the aggregate of the individual motors can be employed. Moreover, synchronous motors can then be installed and assist in correcting the power factor

of the general power load. The mills are generally equipped with jaw clutches which can be open or closed while the shaft is running. The synchronous motor can thus be disconnected from the mills at starting. The selection of squirrel cage or wound rotor induction motor depends upon the local starting restrictions, as the squirrel cage motor will easily bring the shaft up to speed even with all mills connected.

"Direct-current motors are sometimes used when this is the power available, but they are more expensive and not so well suited to the load conditions.

"The calenders, as mentioned, require close speed control over a range four to one. This can best be accomplished by a direct current motor, which is the general practice. A number of schemes have been employed to accomplished this. Among them might be mentioned the multi-voltage and adjustable voltage methods. The motor is excited at constant field strength and the armature supplied with a variable voltage. This variable voltage can be produced by a series of different voltage generators or by a rotary compensator or booster set.

"A modification of the preceding is a three-wire, two voltage source of armature supply combined with adjustable speed by field control. The first mentioned methods produce a wide speed range but are expensive because of the number of machines required for each calender. The second method produces a less speed range but is less expensive, particularly where a large number of calenders are installed. With the more recent general application of commutating poles to direct current motors a greater speed range is permissible with constant armature voltage and varying field strengths.

"This last mentioned method results in the simplest equipment as a whole. The motor must be larger but is therefore more substantial, while the control can be made extremely simple, or it can be made entirely automatic, thus calling for the minimum of attention and care from the operator.

"As the power to drive the mills is by far the greatest portion of the total power, alternating current will generally be selected. This therefore requires a motor generator set or a synchronous converter to deliver current to the calenders. The machines can be used to correct the power factor of the general power circuit.

Motor Control.

"As the motors to drive the mills are run at constant speed, only starting devices are required. A speed controlling device must, however, be furnished with the motors driving calenders. The calenders

require close attention and must be capable of starting and stopping by the simplest means on the part of the operator. This is best met by a control which enables the operator to bring the calender up to the speed by moving the controller handle around to obtain the desired speed. Automatic acceleration should be provided to limit the current input while the controller handle is being moved around. It should

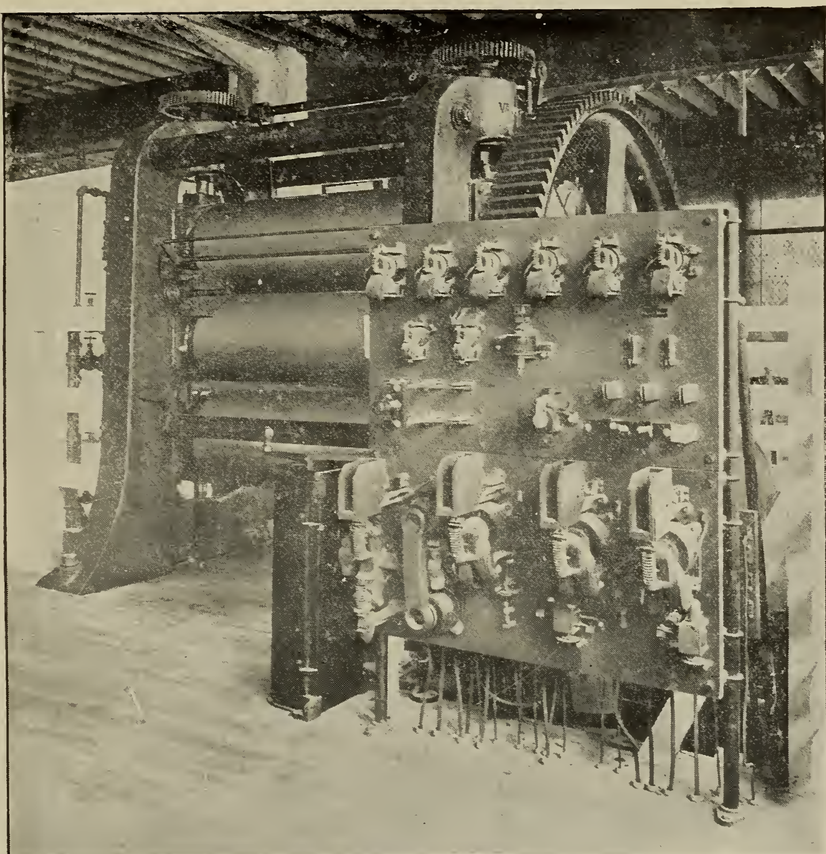


FIG. 116.—MOTOR CALENDER DRIVE.

then be possible to shut the calender down by pushing a button located on the calender. The speed of the calender should be retarded by dynamic braking of the motor. This is to provide a safety feature in respect to the operator in case his hand should be caught between the rolls. Also it is desirable to stop quickly to save material otherwise wasted by the coasting of the motor. It should then be possible to bring the

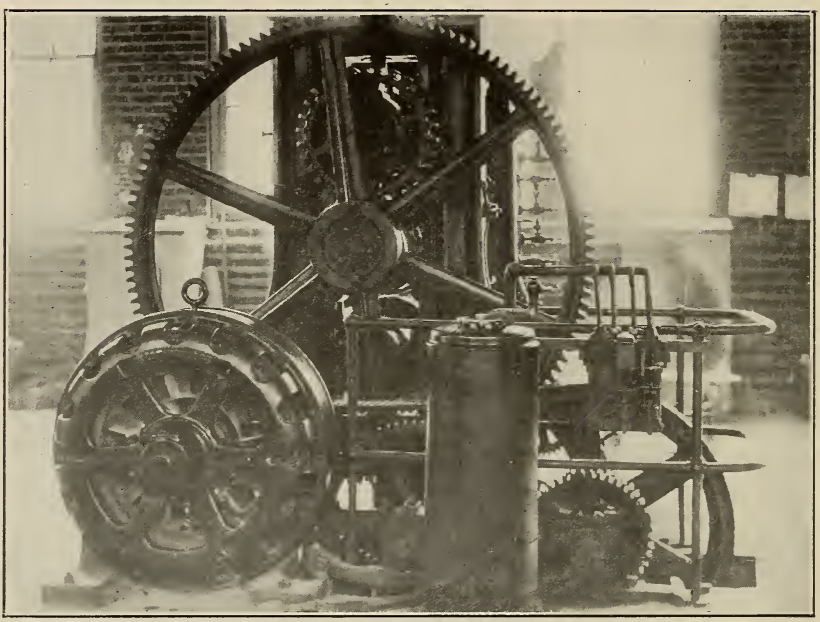


Fig. 117.—Westinghouse Motor Driven Calender.

calender up to the same speed as before by pushing a button on the calender. Means should be provided for reversing the direction of rotation of the motor to assist in manipulating the calendar and also in case anything should be caught between the rolls and it becomes necessary to back it out. The control should also include overload and low voltage release features and be immune from damage to itself or the motor, in case the operator fails to close or open the proper switches."

Motor Calender Drive.

Fig. 116 illustrates a Vaughn three-roll calender equipped with a Westinghouse control. The calender is direct connected to a variable speed motor through cut herringbone gears. The drive is located under the floor. The controller has a number of magnetic switches, relays and resistances for automatic acceleration, overload and low voltage protection and dynamic braking. A master controller of the drum type is provided and the calender is always in full control of the operator. Push buttons are located at convenient points so that the

motor can be stopped almost instantly. A large number of running points are provided so that variations in speed may be obtained at the will of the operator.

Safety Stops.

Workmen employed on calenders and mixing mills are sometimes caught in the rolls, the result being disastrous, perhaps fatal. The ordinary clutch mechanism is so far from the workman that it is impossible for him to reach it in case of accident. The safety stop provides a throw-out within easy reach and can be operated by the hand, foot or even head or shoulders.

Automatic Clutch Throw-Out.

Figs. 118 and 119 show a simple form of clutch throw-out. It consists of a pinion and clutch, the latter being made with a helical shoulder on the inner face. A steel dog is held above the clutch by a latch attached to a light chain carried over pulleys above the mill, terminating in a handle above the rolls. Instead of the handle, a bar placed horizontally across the frame is often used. A slight pull on the chain raises the latch and releases the dog which falls into the open-

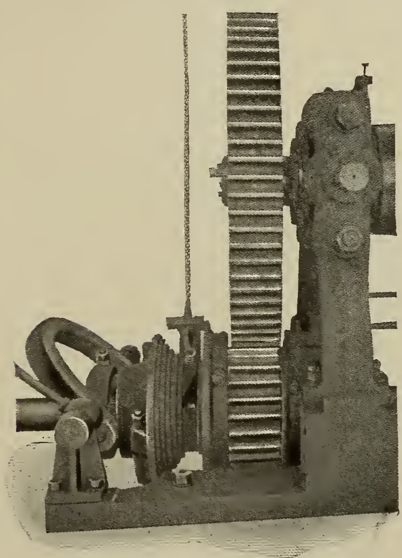


Fig. 118.—Clutch Engaged.

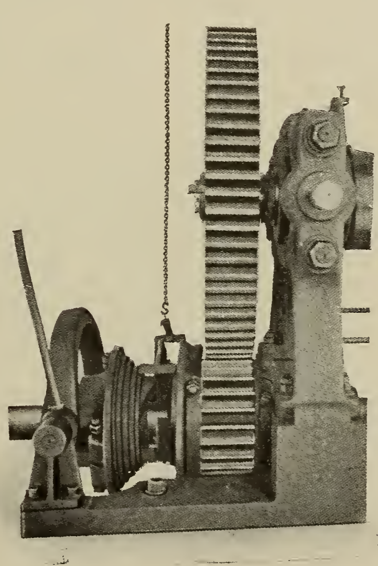


Fig. 119.—Clutch Thrown Out.

Automatic Clutch Throw-Out.

ing between the flange on the pinion and the clutch. As the main shaft revolves the steel dog forces the clutch out of engagement, stopping the machine.

Forsyth Safety Stop.

The Forsyth safety device is shown in Figs. 120 and 121. Across the top of the rolls, in a position readily accessible, are two levers, *A* and

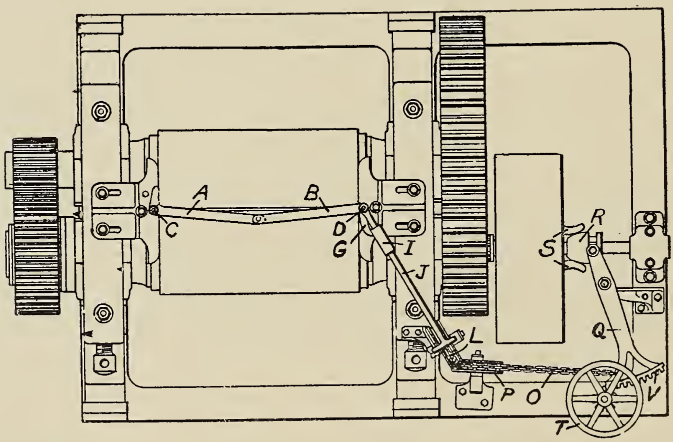


Fig. 120.—Forsyth Safety Stop.

B pivoted at *C* and *D* to the frame of the machine. They are pivoted together and swing loosely on their pivots. The arm *B* has on its hub *D* a hook *G* which, in its normal position engages a lug *H* on the sleeve *I*. This sleeve slides on the arm *J* and supports a weight *K*

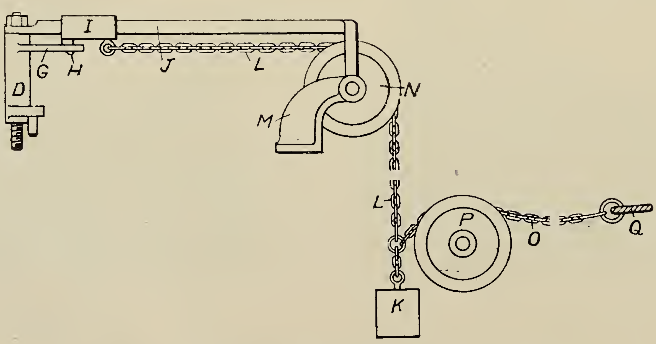


Fig. 121.—Details of Forsyth Safety Stop.

attached to the chain *L*, the end of the arm *J* resting upon the bracket *M*. The chain *L* passes over the pulley *N* and is connected to a second chain *O*. This is connected with the shipping lever *Q* which operates the friction clutch *S*. Normally the parts remain in the positions shown. In case of emergency the lever *B* is pushed back, throwing over the hook *G* and releasing the slide *I*. The weight then falls and pulls the lever over to the left, disengaging the clutch and stopping the machine.

The Farrel Rod Trip Throw-Out.

Another safety device is the Farrel rod trip throw-out, Fig. 122. In this the latch trip *A* is released when the horizontal rod *B* is forced forward or back. This allows the heavy steel dog *C* at the lower end

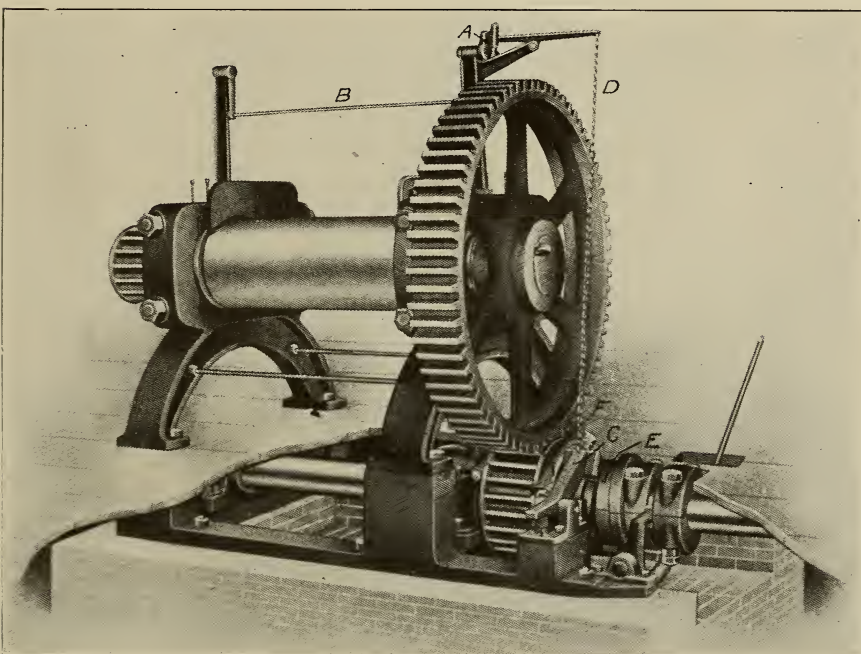


Fig. 122.—Farrel Rod Trip Throw-Out.

of the chain *D* to fall into the opening between the clutch *E* and the pinion flange *F* which forces the two members of the clutch apart, stopping the machine. As an additional precaution this device sometimes has a foot lever located near the base of the machine for tripping.

The Birmingham Safety Stop.

The application of a pneumatic clutch as a safety stop is shown in Fig. 123. The casing *A* is bolted to the driving gear *B* which is loose on the neck of the roll *C*. Keyed to the inside of the casing is a set of friction discs. These alternate with another set fastened to a hub that is keyed to the outer neck of the roll *C*. A circular piston located in the casing *A* and of similar shape, is forced against the discs by air or water under pressure admitted through the operating valve *D*.

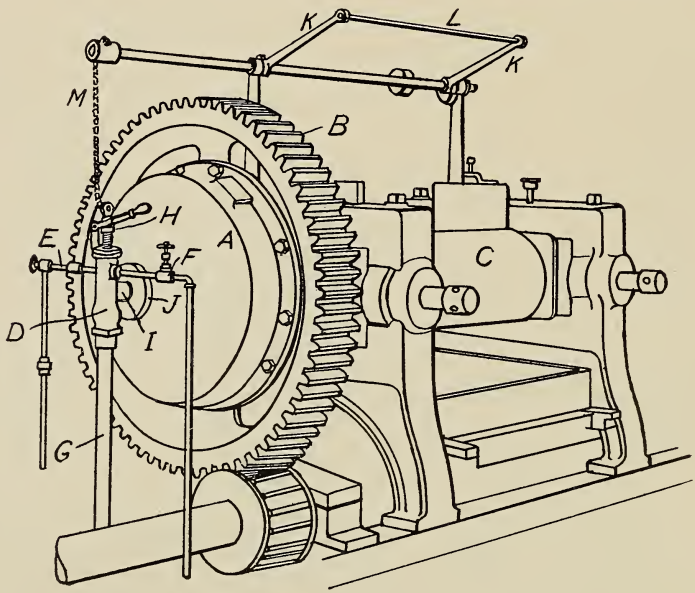


Fig. 123.—The Birmingham Safety Stop.

This valve has inlets *E* and *F* and an outlet *G*. When the rod *H* is in its lower position as shown, the outlet is closed and the air or water passes through the pipe *I* and forces the piston back, which engages the discs and starts the mill. When the cross bar *L* and the arms *K* are pulled down the chain *M* raises the rod *H* and stops the machine.

The Dodge Safety Stop and Brake.

Fig. 124 shows a side elevation of a friction clutch with an automatic brake. The outer casing *A* is keyed to the drive shaft *B* and the inner casing *C* is keyed to the mill shaft *D*. The clutch is operated by hand wheel *F*, pinion and segment rack *G* and levers *H*. In case of emergency the cord or bar over the machine is pulled, releasing the

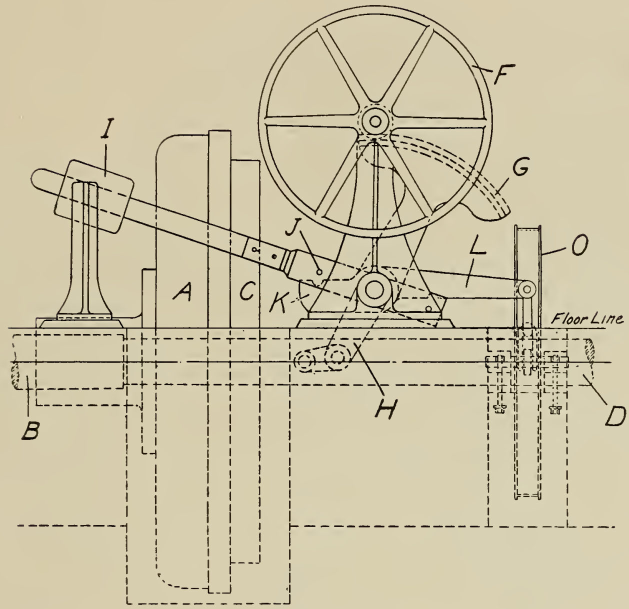


FIG. 124.—THE DODGE SAFETY STOP AND BRAKE.

weight *I*. This engages the pins *J* with the lugs *K*, which raises the lever *L* and applies the brake on *O*.

VARIABLE SPEED BELT DRIVES FOR CALENDERS.

Many forms of variable speed devices are in use in rubber mills and the machine for which they are best adapted is the calender. Where only one or two definite speeds are required, the ordinary reducing gears equipped with proper clutches are best. On the other hand, where a great number of speed changes are required, it is desirable to employ friction driving devices.

THE EVANS FRICTION DRIVE.

A well known type is the Evans, shown in Fig. 126. The driving cone *A* and the driven cone *B* have parallel axes, but are separated from each other by an endless friction belt. This is moved between the cones by the chain *D*, and thus the speed of the driven shaft may be varied. The two cones forced together press against the friction belt. In the overhead apparatus this is done by a lever *C* similar to the ordinary belt shipper and is used to start and stop the machine.

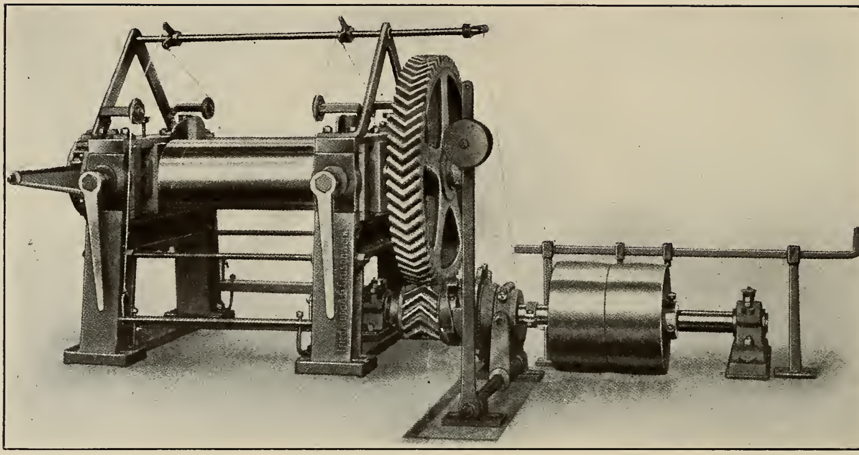


Fig. 125.—The Krupp Safety Stop.

Reeves Variable Speed Transmission.

The device shown in Fig. 127 has hangers cast integral with the frame and can be fastened to the floor or ceiling. The two cone shaped discs *C C* are spline mounted, with their apexes facing, on the drive shaft *A*. Another pair are similarly mounted on the driven shaft *B* forming a groove for the endless V-belt. These discs slide freely on their shafts but rotate with them. They are moved toward or away from each other by the levers *D D*, pivoted at *G G* and operated by a right and left screw. The speed of the driven shaft is varied by turning this screw to the right or left. This is done by gears *E*

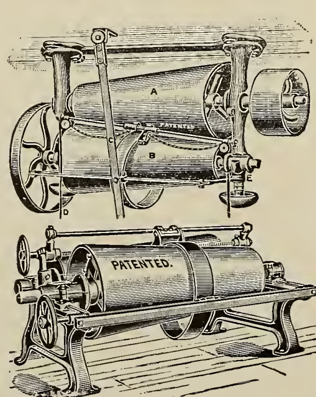


Fig. 126.—Evans Friction Drive.

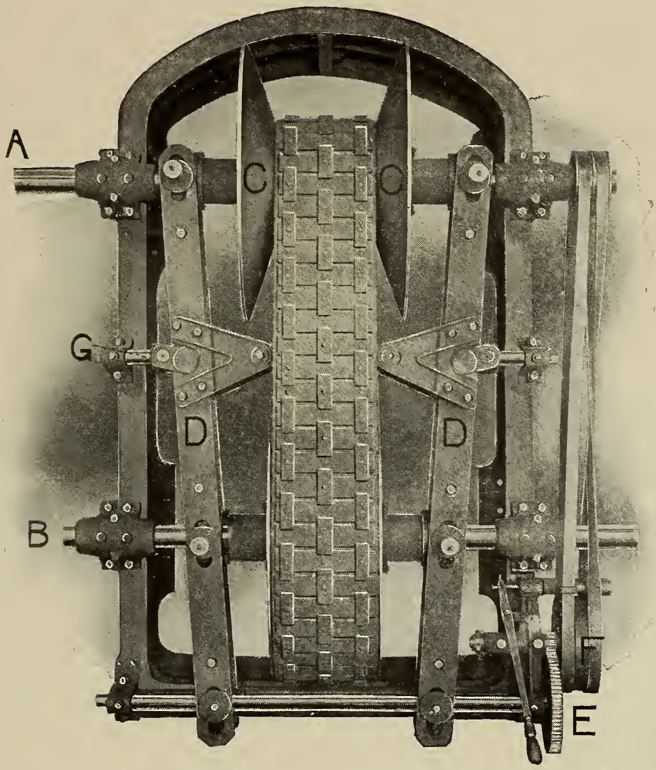


FIG. 127.—THE REEVES VARIABLE SPEED TRANSMISSION.

and a straight or cross belt on the tight pulley *F*, driven from shaft *A*. In the illustration the discs on the driving shaft are shown operating the shaft *B* at the minimum speed.

THE BIXBY VARIABLE SPEED DRIVE.

A plan view of this device is shown in Fig. 128. The hangers *C C*, support two parallel shafts *E* and *G* upon which are mounted cone pulleys *A* and *B*. The shaft *G* is mounted in hangers which swing on the shaft *R* journaled in the hangers *C C*. The cone pulley *B* swings away from *A* and by gravity tightens the cone belt *L*. Bolted to the bottom of the rigid hangers is a guide bar *I* on which slides a yoke *J* bearing two vertical rollers *K K*. These project between the cone pulleys, spanning the lower part of the belt *L* which is shifted by a cable *M* that passes over sheaves *N*. The adjustable weight *P* is mounted on the lever *Q* fixed to the shaft *R*. This forces the pulley

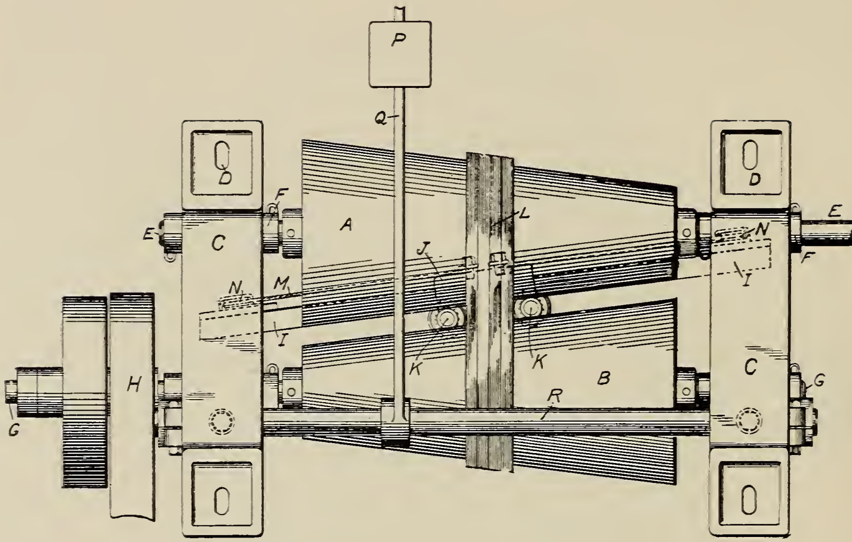


FIG. 128.—THE BIXBY VARIABLE SPEED DRIVE.

B away from *A* and tightens the belt. The belt *H* drives the shaft *G* and the cone pulley *B* and the belt *L* transmits the variable speed to the cone pulley *A* and the shaft *E*.

A MODEL CALENDER ROOM PLAN.

Fig. 129 shows a typical layout of a modern calender and mill room.* The main features are taken from the calender room of an existing rubber factory and are applicable to almost any sized installation.

The room is 75 feet wide by 150 feet long, with a 1½-inch maple floor laid on concrete. On either side of the room is located a line of six mills with 20 by 60-inch rolls. Each line is driven by a 300 horse-power motor, with reducing gear, located midway between the mills, there being three on each side of the drive. Located between the mill lines are twelve 3-roll calenders, with 24 by 66-inch rolls, equipped with individual motor drives. A central passageway, 8 feet wide, extends the length of the room.

* "A Model Calender Room," by Morris A. Pearson, India Rubber World, December, 1912.

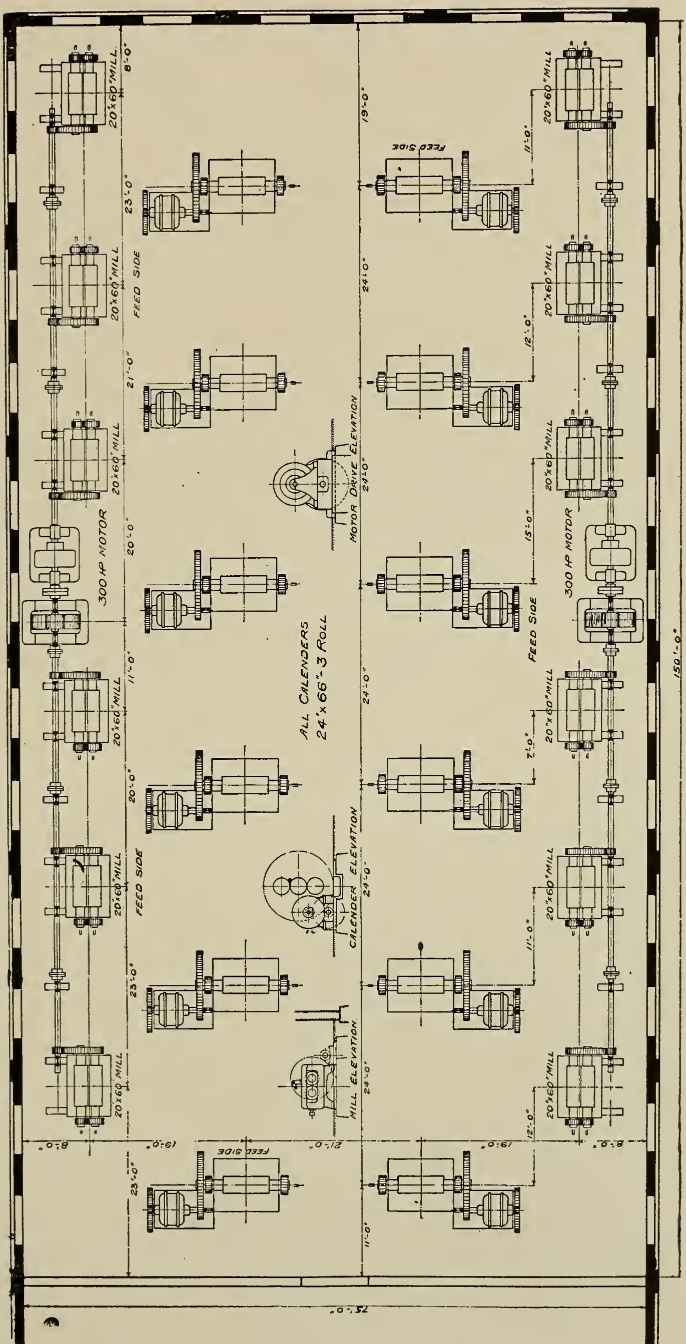


FIG. 129.—A MODEL CALENDER ROOM PLAN.

The drive is with the motor located directly over the line shaft, where it is easily accessible. Power is transmitted from the motor to the line shaft by cut double helical gears enclosed in oil-tight casings. The only part of the drive to extend below the floor is the lower part of the gear casing.

The motor is connected with the reducing gear by a magnetic coupling and safety stop, which is operated by hand or foot trips from any mill on the line. A magnetic brake used with this coupling is automatically applied when it is cut off. The power required for energizing a 300 horse-power magnetic coupling is only 2 amperes at 120 volts, and for the brake 1.75 amperes at 120 volts—both working continuously. It will thus be seen that the operating cost is comparatively nothing.

All line shafting is 6⅜ inches in diameter and is located high enough to allow everything connected with the mill line to clear the floor.

The calenders have individual drives, each machine being driven by a 75 horse-power variable speed direct current motor. The motor speed has a variation of 1 to 3 and permits a delivery on the calender of from 5 1-3 to 16 yards per minute when running friction and from 8 to 24 yards per minute when running even. The motor controller is connected with a rod trip, located in front of the rolls, for emergency use.

The Bitterlich Calender Room Layout.

The calender room plan shown in Fig. 130, is a modification of Pearson's and embodies several special features. This is designed for the most economical production from an operating point of view. It should, however, be borne in mind that it would not hold good for all classes of rubber mills, since the sizes of calenders and mills and the processes of manufacture vary.

It must be kept clearly in view that materials in process of manufacture should move in one direction to and from the machines, in an orderly manner, and without waste of time and energy.

The essential features are as follows:—

1. The calenders are located near the windows and the mills nearer the middle of the room. The process of calendering, dealing with the product in a more finished stage, demands the best light, while the function of the mill is merely to warm and soften the gum.

2. The mills and calenders are placed as near to each other as is practicable, to reduce to a minimum the distance traveled in delivering the batch of gum to the calender. In minimizing this distance it

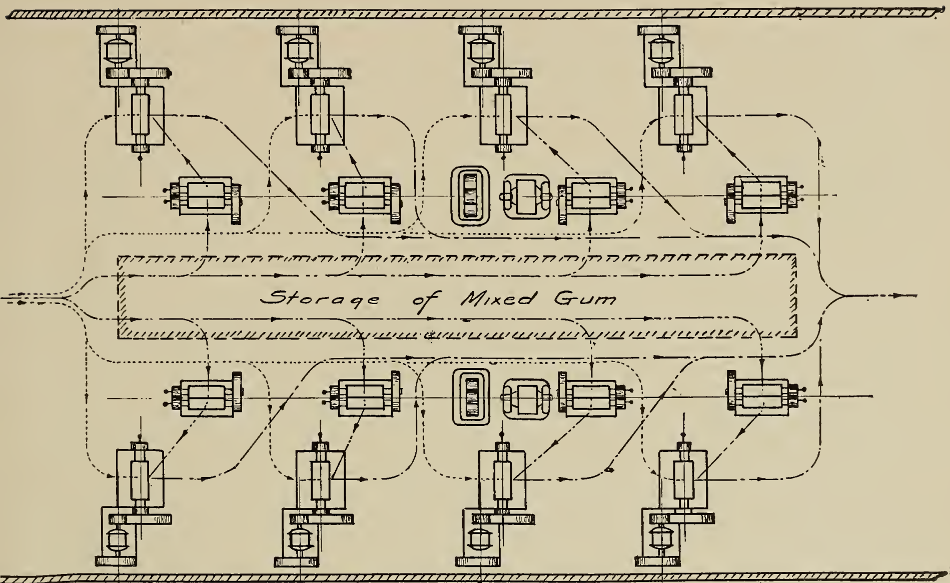


Fig. 130.—The Bitterlich Calender Room Layout.

is necessary to lengthen the distance which the fabric and finished product travels. The latter are, however, delivered in larger quantities than the rubber batches and therefore have a less number of journeys to make.

3. The central portion of the room is devoted to the storage of mixed gum. This allows piling the gum as high as practicable, without obstructing the light, and since rubber is affected by light, it should be stored in the darkest part of the room. While some light may be available from a saw-toothed roof with a single story building, it is desirable to obtain all the daylight possible at the calenders from the sides and from above.

4. The building should be of one story about 20 feet high, equipped with a roof of sawtooth construction and spanned by a crane the entire width of the building. This would allow quick removal of rolls, frames and all other heavy parts requiring renewal and repairs. With the mills in the middle, the shafting should be below the floor. This can be arranged by building a tunnel, or better still, a basement, and carrying the foundations of the machinery to the floor below. Then all steam and water pipes would be located in this basement.

CHAPTER VIII.

MOLDS, METAL AND RUBBER.

MOST of the molds used in the manufacture of rubber goods are made of iron or steel. Soft metal molds are, however, used to an extent, especially in hard rubber work. For special work molds have in the past been carved from blocks of soapstone. Their value over metal molds, however, is not apparent. Molds of plastic composition are also used in dental and stamp work. The strips of cloth wound about hose or tires to keep them in shape while curing, as well as the beds of French talc or soapstone in which goods are buried, are really molds. In a word, almost all rubber goods, except clothing and dipped goods, may be classed as molded work.

Molds made of rubber are also often used. They are sheets of vulcanized rubber upon a foundation of heavy duck, the face of the rubber bearing the design that is to be transferred, say to a mat or tread. Such molds have a supporting edge of fabric and rubber around the edges, or are set on an iron plate with supporting edges.

Rubber molds are made after a German formula that calls for 25 parts of rubber in solution and 75 parts of white of egg. After the solvent has been evaporated, enough sulphur is added to ensure vulcanization. The product is said to be full of nerve and to stand much wear.

Rubber molds are also used in lines of manufacture other than rubber. For example, in shaping celluloid in certain work rubber vacuum bags are employed. In pattern making, in candy manufacture and in the molding of a variety of plastics such molds are often used.

The molds used in rubber manufacture are close molds. That is, they consist of two or more parts accurately fitted together and are lined up with dowel pins or guides. The parts when placed together form an exact positive of the article to be manufactured.

Metal molds are generally made by a manufacturer who is a specialist in this industry. Strictly speaking it is a part of the die maker's art and requires expert knowledge in the designing and skilled mechanics in the making. Many molds are made by the rubber manufacturers in their own machine shops, particularly in mechanical and hard rubber work where a great variety of patterns are used. There is such an infinite variety of rubber molds that only a general description of the methods used can be given.

Many molds are made by simply running plates of iron through a planer. Others call for engraving or die sinking in metal plates. In others the first step consists in obtaining a perfect reproduction of the object to be molded. This is turned up from wood or made from an original. From this a matrix is made of a plastic substance such as gutta percha, wax or plaster of paris. This matrix comes from the model in two pieces. each a perfect reproduction or intaglio of one half of the original model. These two parts are then treated as patterns from which sand molds are cast in iron or soft metal. The final molds are then machined and accurately fitted together and provided with dowel pins or guides so that the mold can be separated and put together again in perfect register. In very small articles the impressions are duplicated several times and plate molds containing several dozen matrices are made. This type of duplicating mold is limited in weight as it should not be too heavy to handle from the bench to the press.

Another method is to make the matrices thin or shell like and enclose them in cast iron or other metal. The advantage is that when the mold becomes worn the shell-like matrices can be renewed. When soft metal is used this style of mold with a cast iron frame gives the best results.

Mold making by electrical deposition of metals is, on account of the plant required, possible only in the largest factories. For making a mold by this process a model is first made from wax or plaster of paris, with wire or iron supports. The model may thus be obtained in a single piece or in two pieces. It is next treated to an electrolytic bath of copper sulphate, where it constitutes one of the electrodes and receives a coating of copper, the thickness of which depends on duration of immersion. The whole may then be coated with nickel to protect the surface and so that it can be polished. If the model is in a single piece a closed mold is formed; if in two parts the mold will open at one side and the edges of both parts will fit together accurately. Closed molds are cut into two portions by a saw. Molds obtained by electrolytic deposition are not very thick or strong. They are therefore backed by type metal or plaster. This is done by placing the mold in a shallow wooden box. The plaster of paris is run into this box until full. When molds are required for use under pressure they are reinforced by a thick electrolytic nickel deposit, and foundry metal is used for backing, instead of plaster. Electrolytic molds are easily and cheaply made but their use in rubber mills is questioned on account of their lack of sharp edges and ability to wear well.

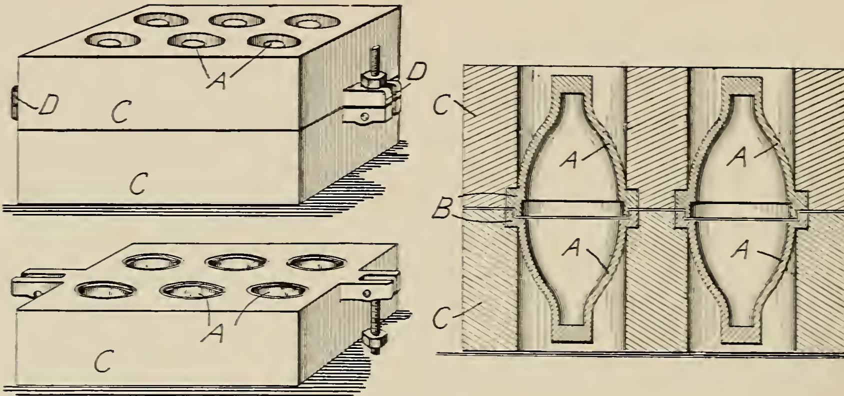


FIG. 131.—THE EGGERS QUICK CURING MOLD WITH SOLID CAST IRON FRAME.

Portland cement is sometimes used as a material for mold making. It is placed in metal flasks and the desired shape formed. It is then coated with a layer of soluble glass (potassium aluminum silicate) and chalk, by which the details are worked up. Magnesia cement can be used, resulting in a very hard and durable mold. Such a mold presents smooth surfaces, sharp edges and gives good detail.

THE EGGERS QUICK CURING MOLDS.

The Eggers system of making soft metal mold castings for blown work is interesting. The walls of molds are often of unequal thickness. This causes loss of time in vulcanizing and cooling, extra work in handling, uneven vulcanization, etc. Fig. 131 shows one form of the Eggers mold designed to do away with this defect. The shells A are cast from soft metal such as tin, type-metal, aluminum, etc. These shells are then placed in a female die of corresponding shape, into which

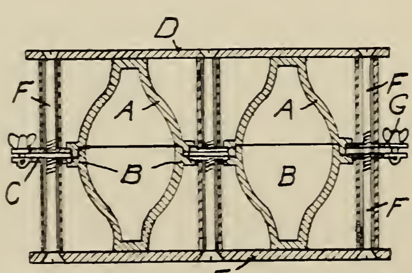


FIG. 132.—THE EGGERS QUICK CURING MOLD WITH OPEN WROUGHT IRON FRAME.

a male die is pressed. This swages the metal shell into final shape. The swaging removes all defects from the interior of the shell and gives the surface a smooth, glassy finish. The flanges *B*, hold the shells in position in the cast iron frames *C*. The two parts of the frame are held together by clamps *D*.

The Eggers Open Frame Mold.

Another form of the Eggers mold is shown in Fig. 132. In this the shells are also made of uniform thickness and are mounted in light iron frames. Referring to the drawing, the shells *A* are formed with flanges *B*, which fit into recesses in plates *C*. These plates are connected with the upper and lower frame plates *D* and *E* by screw bolts *F*, and the mold sections are clamped together by thumb screws *G*. The

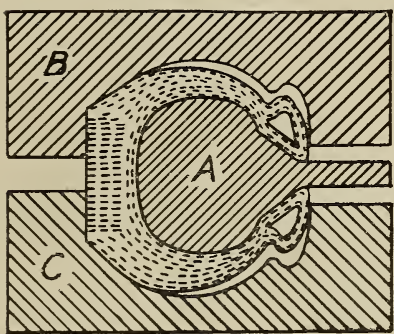


Fig. 133.

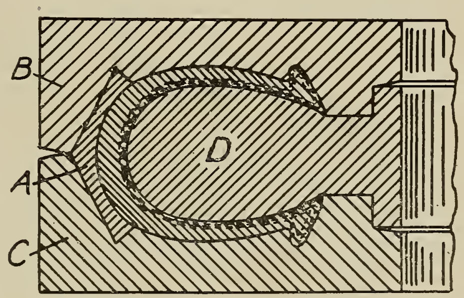


Fig. 134.

Typical Two-Part Molds.

mold shells are cast from soft metal and finished smooth by swaging. In addition to the advantage of even vulcanization is the lightness of the outfit when a number of the molds are clamped together. The cost is less also, as this type weighs but one-fourth as much as the ordinary kind.

Types of Metal Molds.

Molds for motor tires are usually two-part, with a separate core inside. The rough castings are turned up on a lathe. If it is, for example, a "Bailey tread," round depressions are milled in the inner surface of the mold. For this is used a milling apparatus on a flexible shaft, the depressions being accurately located by an indexing plate. Extreme accuracy characterizes every part of tire mold manufacture. A variation of more than 0.002 of an inch in the size of mold or core would mean its rejection.

Fig. 133 shows a typical form of two-part mold with core for tires, consisting of the core *A* and mold portions *B* and *C*. The illustration shows a cross section of only one side of the mold. The tire is first built upon the core and placed in the mold, which is then subjected to pressure in a press-vulcanizer.

Fig. 134 shows another form of tire mold of special design. In this the tread portion is formed with an interchangeable segment ring *A* with inclined faces to fit the faces on the mold parts *B* and *C*. When the mold parts are pressed together the ring *A* forces the tread of the tire radially against the core *D*, and holds the tire in place during vulcanization.

Rubber articles, such as stoppers which have knobs or handles of irregular shape, often require molds of three or more parts. Fig. 135 shows a mold for making waste plugs for baths, sinks, etc. The mold

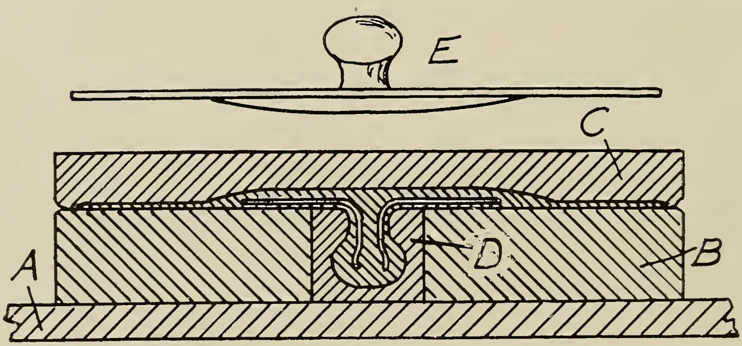


Fig. 135.—Type of Five-Part Mold.

comprises five parts, a lower plate *A*, a ring *B*, the upper plate *C* and a two-part central block *D*. After vulcanization the parts of the mold are taken away one at a time to remove the completed plug, which is illustrated at *E*.

The Bland Molding Machine.

In Fig. 136 are two views of the Bland machine, which mechanically feeds the compound into the molds. In the illustration the machine is arranged to mold telephone receivers, although it may be used for making other articles by the substitution of the proper molds. The drawing on the left is a transverse section, while that on the right is a longitudinal section.

Beginning with the drawing on the left, the machine comprises a main casing *A*, having at the top a cylinder *B* with a piston *C*. At the

bottom is a cylinder *D* with a piston *E*. On one side is a cylinder *F* with a piston *G*, and on the opposite side is a cylinder *H* with a piston *I*. Each of these pistons is reciprocated by steam pressure, which may be admitted at either end of the cylinder. Inside the casing are three mold sections *J*. The central one is stationary and the two outside sections are dovetailed to the pistons *G* and *I*, so that the molds may be opened and closed. Above the molds is a stationary block *K* with twelve funnel-shaped feed tubes *L* which register with the molds. Between this block and the molds is a sliding plate *M* having holes which register with the

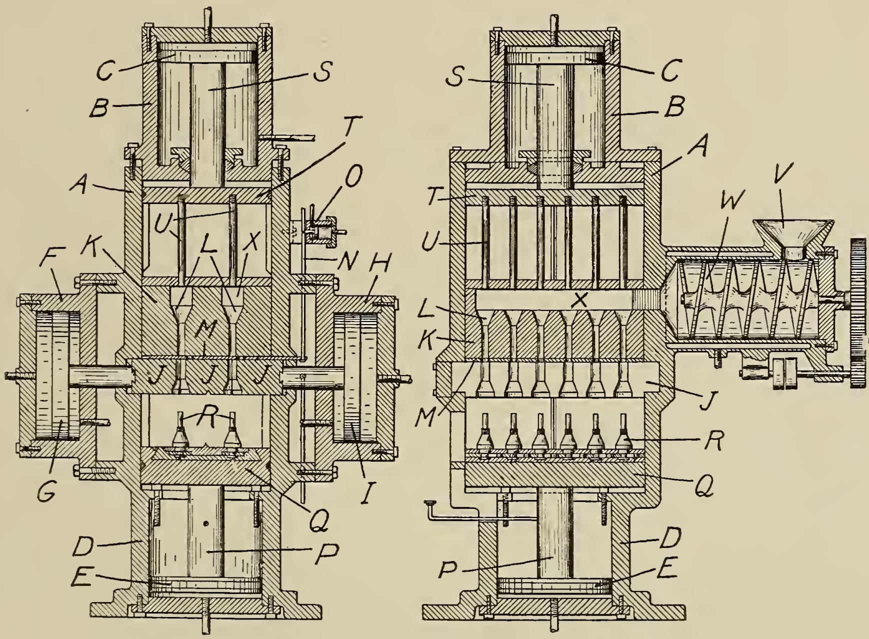


Fig. 136.—The Bland Molding Machine.

feed tubes. The plate is operated by a lever *N* attached to the piston rod of a small steam cylinder *O*, so that the holes in the plate may be moved out of line with the feed tubes to stop the flow of compound into the molds. On the upper end of the piston rod *P* is a plate *Q* which carries the twelve cores *R*. On the lower end of the piston rod *S* is a plate *T*, into which are threaded tamping rods *U* for packing the compound into the molds.

Referring to the drawing on the right, the compound is fed into the hopper *V* and forced by the screw *W* into the spaces *X*, from which

it passes into the feed tubes *L*, the lower ends of which are closed by the plate *M*. The piston *E* is raised to bring the cores into the molds, which are then closed by the moving pistons. The plate *M* is then moved to open the feed tubes, and the compound is forced into the molds and packed by the tamping rods *U* operated by the piston *C*. The molds are opened by moving the pistons outwardly, after which the molded articles, on the cores, are removed for vulcanization.

Apparatus for Making Rubber Molds.

A forming and vulcanizing apparatus for making elastic rubber molds or patterns for ornamental objects, or for producing metallic articles by electro deposition, is illustrated in Fig. 137. *A* is the vulcanizing vessel having a hinged cover *B*, supplied with bolts *C* for hermetically closing it. Within this vessel is a steam-chambered platen *D* supported on lugs *E*. This platen has inlet and outlet pipes *F* and *G*

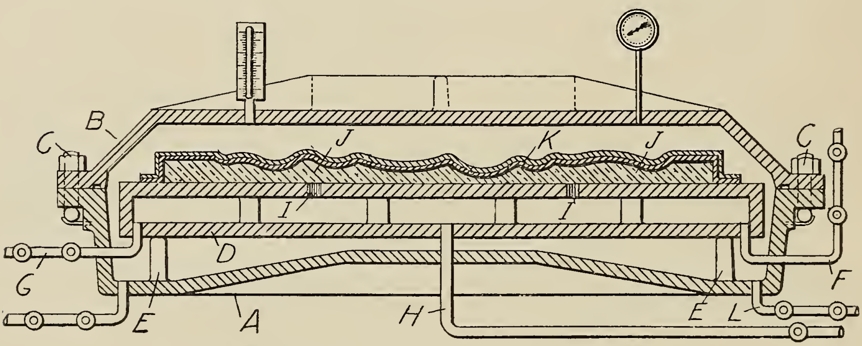


Fig. 137.—Apparatus for Making Rubber Molds.

for supplying steam for heating it. A pipe *H* connected with the platen *D* is attached to an air pump (not shown.) The upper surface of the platen is provided with a number of holes *I* to furnish air communication between the steam chamber and the inner surface of the mold. The pattern *J* is made of plaster paris or other porous material and its upper surface is shaped to produce the desired design. The mold is made from two thin sheets of rubber, one of which is partially vulcanized, while the other is unvulcanized. The combined sheet *K* is placed upon the pattern *J* with the partially vulcanized side up, and the edges of the sheet are cemented to the surface of the platen all around the pattern to exclude air from the under surface of the mold. The air is exhausted from the platen *D* by the air pump connected to the pipe *H*, and the suction through the porous pattern causes the rubber sheet to conform to its surface. Steam is then admitted at about 20 pounds

pressure to the vessel *A* through pipes *L,* which causes additional pressure on the sheet of rubber and firmly depresses it into every cavity and outline of the pattern, and vulcanizes it. The completed mold will retain its shape and is easily stripped from castings of intricate design.

Care of Molds.

To prevent the articles from sticking, molds are heated and brushed over with soft soap so that a film is deposited on the interior surface. Another method is dusting with French talc, plumbago or powdered soapstone, and in some cases a coat of glycerine is applied.

Molds should be kept clean and when they gather scale from the sulphur, soap or talc, it should be removed. This fouling of molds is quite a serious matter and many preventives have been devised. One is to coat the inner surfaces with block tin, which can be removed by melting when foul. The sand blast is used for cleaning in some mills. A smooth talc sand, however, must be employed as a sharp silica sand would injure the surface. A circular wire brush mounted on a flexible shaft is also a quick and efficient tool for cleaning molds.

Motor Driven Mold Cleaner.

Fig. 138 shows the Plank motor driven, flexible shaft outfit which is often used for cleaning molds. The illustration shows the shaft with

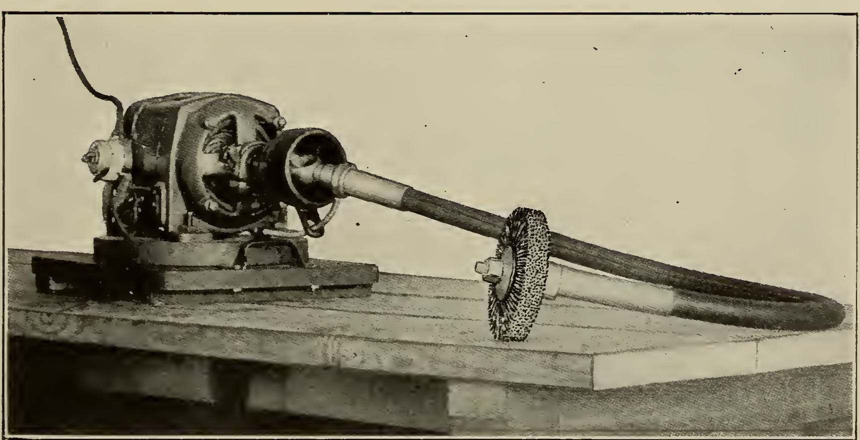


Fig. 138.—Motor Driven Mold Cleaner.

a circular wire brush. The flexible shaft is attached to the motor by a universal joint, which allows a wide range of movement of the brush. The shaft is usually from 6 to 8 feet long.

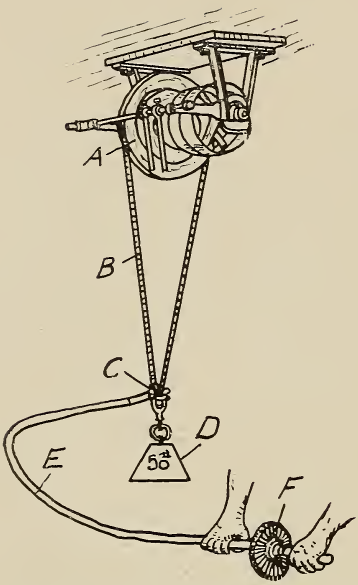


Fig. 139.—Belt Driven Mold Cleaner.

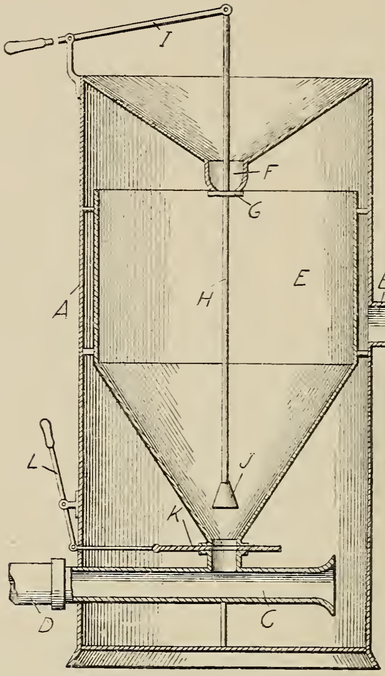


Fig. 140.—Sand-Blast Cleaner.

Belt Driven Mold Cleaner.

Fig. 139 shows another form of flexible shaft driven from an overhead counter shaft. Mounted on the counter shaft is a large sheave pulley *A* over which runs a round belt *B*. This belt drives the grooved pulley *C*. The weight *D*, serves to maintain tension in the belt. The pulley *C* drives the flexible shaft *E*, on the end of which is mounted a circular wire brush *F*.

Sand-Blast Cleaner.

One type of sand-blast for use in cleaning molds. is illustrated in Fig. 140. The device comprises an outer casing *A* having an air-inlet pipe *B* and an outlet *C*, to which rubber hose *D* is attached. The outlet pipe *C* receives sand from a hopper *E* supported inside the casing. Sand is fed into this hopper through a valve *F* which is opened and closed by a disk *G* on the rod *H*. This rod is controlled from the outside by the lever *I*. On the lower end of the rod *H* is a plunger *J*, which clears the outlet pipe in case it becomes clogged. The flow of sand from the hopper *E* is controlled by a sliding valve *K* operated by the lever *L*.

Machine Tools for Mold Making.

Many rubber mills have a mold making department that is in reality a completely equipped machine shop. The machine tools that are required in such a shop are:

An 18-inch engine lathe with a three-step cone and double back gear. It has an 8-foot bed and takes 2 feet 6 inches between centers.

A 24-inch planer with an 8 foot bed and one or two heads.

A shaper with a 20-inch stroke and a table travel of 22 by 14½ inches. It has a universal vise that opens 10¾ inches.

A plain milling machine back geared with a table feed of 24 by 19 inches and a cross feed of 7 inches. Universal index centers for gear and worm cutting, spiral milling, etc., are also necessary.

A 20-inch drill press with power feed and tapping attachment. The diameter of the table is 16½ inches.

A 13-inch sensitive drill with a capacity up to a ⅝-inch hole and a spindle feed of 4½ inches.

A 13-inch speed lathe with a set-over swivel tail stock and a distance of 48 inches between centers.

A universal tool grinder for grinding reamers, cutters and other tools. This can also be used for surface grinding.

An emery wheel bench grinder and grindstone.

A swing frame grinder that consists of an emery wheel mounted on a flexible shaft.

For soft metal molds, a 23 x 34-inch brass furnace with drop grate is required as well as an equipment of iron bowls, ladle and crucible tongs.

CHAPTER IX.

VULCANIZERS—GENERAL TYPES.

IN curing or vulcanizing there are two processes, the hot and the cold. In the first the application of heat is as follows: open steam heat, hot air or dry heat, hot water, electric heat, hot melted sulphur, solar heat and Ultra-Violet rays. The cold cure consists of two methods, the immersion of uncured rubber in a bath of chloride of sulphur, or the exposure to chloride of sulphur fumes. The apparatus for applying the cure is infinitely varied. For the open steam heat there are horizontal vulcanizers and vertical kettles; for dry heat, jacketed vulcanizers; for the "acid" or cold cure, immersion tanks; for the vapor cure, vapor chambers; for the solar cure, sunning tables; for sulphur baths, heated tanks. All of these general divisions have scores of types of appliances for the vulcanization of special goods.

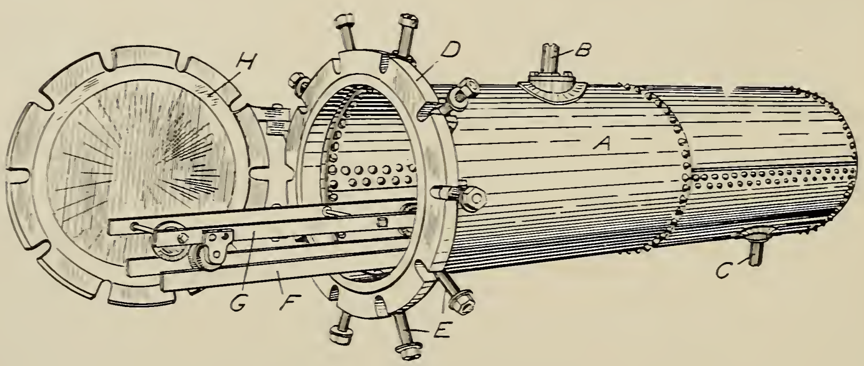


Fig. 141.—Horizontal Vulcanizer.

The manufacturer does not know exactly what chemical changes occur during vulcanization. Nor does the baker know what happens chemically when he bakes bread. Experience enables the bread baker and the rubber baker to produce goods in great quantities that are in every way acceptable. It is probable that for years to come off-hand tests for vulcanization will be made by denting with a horny thumb nail or by observing the slowly fading tooth marks made by biting a sample under test.

The method of vulcanization most commonly employed is the open steam cure. What is known as a vulcanizer or heater is used. It is built like a horizontal boiler shell with a door at one end (sometimes at both ends). In this the goods to be vulcanized are loaded. They are wrapped in cloth, buried in talc or soapstone, or confined in molds to preserve their shape as they soften before vulcanizing begins. The door is then closed and live steam turned in and kept at the proper temperature until vulcanization is effected. While vulcanizers were formerly made by almost any boiler maker, they are today usually furnished by manufacturers of rubber machinery. The standard sizes run from 12 to 84 inches in diameter, and of any length required.

Horizontal Vulcanizer.

The simplest form of live steam vulcanizer is shown in Fig. 141. *A* is the shell; *B,* the steam inlet; *C,* steam outlet; *D,* door flange; *E,* swinging bolts, and *H,* the door. The carriage track *F* is set in grooved stands riveted to the shell, and moves with the car *G* when loading and unloading.

Vertical Vulcanizer.

Fig. 142 shows the ordinary vertical or kettle vulcanizer, which is also of the live steam type. It is a heavy iron pot provided with

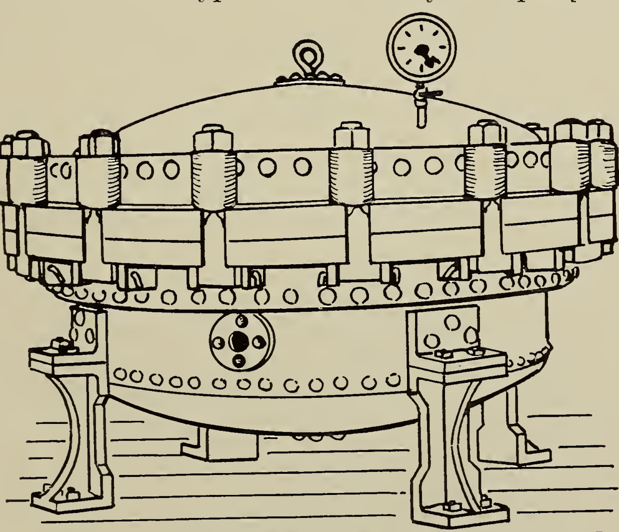


Fig. 142.—Vertical Vulcanizer.

a bolted-on head. It has the usual steam gage, inlet and outlet connections and drain pipe. This vulcanizer is so simple in construction that the illustration explains itself.

Horizontal Jacketed Vulcanizer.

Fig. 143 shows a horizontal, jacketed vulcanizer, having an outer wall *A*, and an inner wall *B*. Between these walls is a space *C*, which serves as a heat insulator when the open cure is used in the chamber *D*. In the dry heat process steam is introduced into the space *C* through the inlet *E*, in which case the main inlet *F* is closed. Pressure valves *G* and *H* are provided in the inner and outer walls, while drain cocks *K* and *L* allow condensation to be drained off. The goods to be vulcanized are placed on a long car *M* and run into the heater on the track *P* from an outside track *N*. The door *Q* is then closed and fastened by the bolts *R*, and steam is turned on.

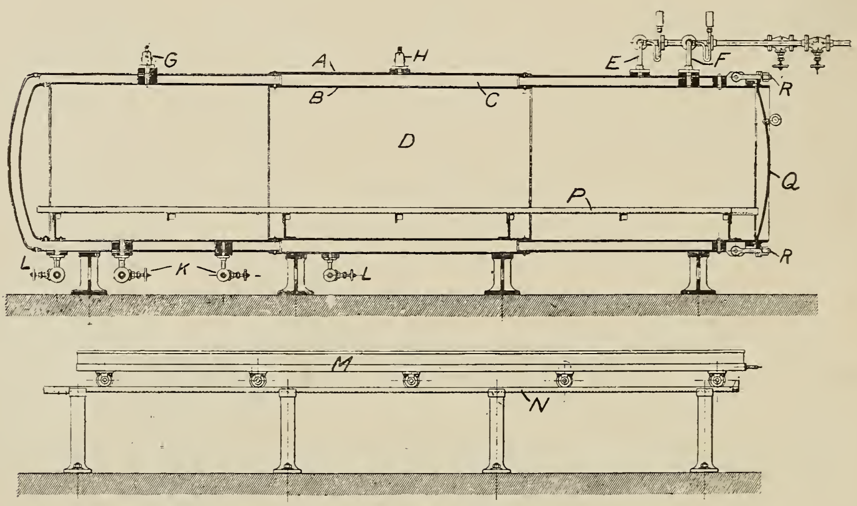


Fig. 143.—Horizontal Jacketed Vulcanizer.

Dry heat in ordinary practice means air heated by steam confined in pipes or in jackets adjacent to the air. In the olden time it was, however, customary to have the dry heaters set above coal or wood furnaces, the heating being done by the flame on the outside.

Vertical Dry-Heat Vulcanizer.

In Fig. 144 is shown a vertical, jacketed dry heat vulcanizer. It has two shells *A* and *B* and is supported in a pit *C* by the flanges *D*. The hinged cover has eye bolts *E* and is clamped in place by swinging bolts. In the cover is a tube *F*, closed at its lower end, in which a thermometer is inserted to record the temperature of the interior.

Dry heaters, which are really oven rooms twenty to thirty feet long and eight to ten feet high, are also used in certain lines of manufacture, such as shoes and clothing. In them the principle is

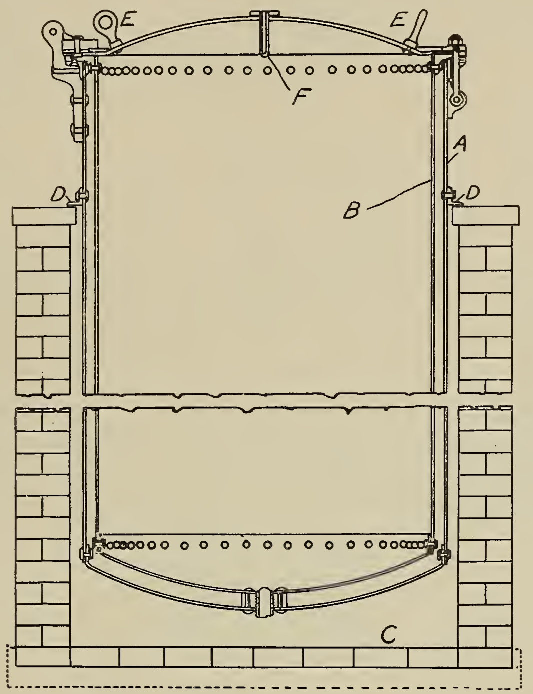


FIG. 144.—VERTICAL DRY HEAT VULCANIZER.

the same as in the smaller dry heaters just described. The newer types of dry heaters where air under pressure is used are described in Footwear, as is also the so-called vacuum cure.

THE SEABURY VULCANIZER.

Seabury's hot-jacketed vulcanizer, illustrated in Fig. 145, is of the horizontal type, having a heating jacket to assist in keeping the steam at a high temperature and prevent it from condensing on the walls. The goods are placed in *A*, surrounded by *B*, which leads directly from the fire box *C*, so that the flames and hot gases surround the vulcanizer and pass up through the flues *D* into the chimney *E*. Steam is admitted through the perforated pipe *F* which runs along the bottom of the vulcanizer. The usual fittings are a blow-off valve *C*, gage *K* and thermometer *L*. The door *H* is mounted on a roller so that it is easily moved.

French Vertical Vulcanizer.

Fig. 146 shows a French type of vertical vulcanizer in which the door is provided with a counterweight. When closed, the door is clamped to the cylinder by bolts *A*, hinged at *B* so that they can be swung quickly into the slots in the flanges. The counterweight *C*

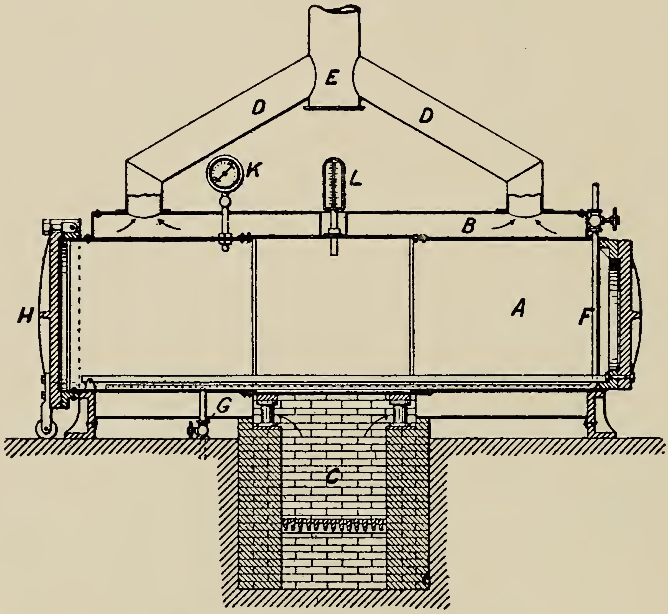


Fig. 145.—The Seabury Vulcanizer.

is adjusted to balance the door, for ease in opening and closing. The vulcanizer has a steam inlet *D*, drain cock *E*, gage *F*, thermometer *G* and connection *H* for a pressure relief valve.

The Fowler Steam Separator and Vulcanizer.

The Fowler apparatus, Fig. 147, is designed for uniform vulcanization and to prevent the formation of blisters.

When water is evaporated, gases such as oxygen, nitrogen, carbonic acid and ammonia are freed and pass into the vulcanizer with the steam, where they remain as fixed gases and do not condense. Fowler's process is intended to remove these gases from the water before it is used to produce steam for vulcanization. This is done by heating the water, then cooling it, and removing the freed gases.

The water is sprayed from a supply main *A* into a closed tank *B*. Here the water and its gases are separated, the gases being drawn off

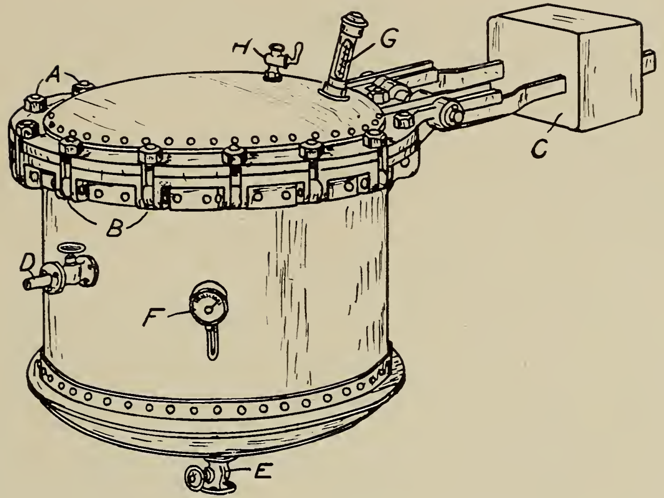


FIG. 146.—FRENCH VERTICAL VULCANIZER.

through the pipe *C* by pump *D*. The water runs off through a pipe *E* into a supply tank *F*, from which it is forced by the pump *G* into the boiler *H*, arriving there free from gases. *V* is the vulcanizing tank, having a pipe *I* connected with the boiler for the admission of steam. Through the pipes *K* and *L*, the air can be exhausted from the vulcanizer by the air pump *D*.

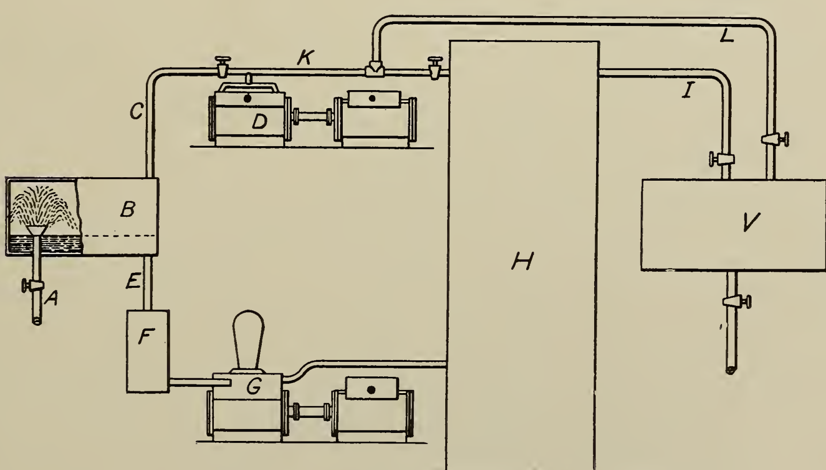


FIG. 147.—THE FOWLER STEAM SEPARATOR AND VULCANIZER.

The Wittenberg Vulcanizer.

Fig. 148 is an apparatus in which the heat and pressure in the heaters is varied independently of each other. The low pressure chamber is for porous goods, while dense effects are secured in the high pressure chamber.

A and *B* are two vulcanizers heated by closed steam pipes *C* and *D* and connected by pipe *H,* which has cut-off valve *I*. Pipe *G* connects *B* with the suction side of the pump *E* and has a cut-off valve *S*. Pipe

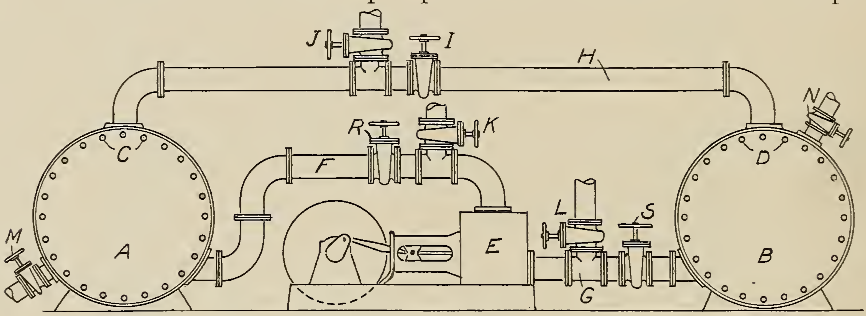


Fig. 148.—The Wittenberg Vulcanizer.

F connects *A* with the pressure side of the pump and has a cut-off valve *R*. Valves *J, K, L* and *M* are air vent valves. Different pressures are obtained in the heaters *A* and *B* by operating the pump and opening and closing the proper valves.

Continuous Processes.

The usual vulcanization of rubber goods is of necessity intermittent. It consists of placing shaped articles in some sort of mold, shut-

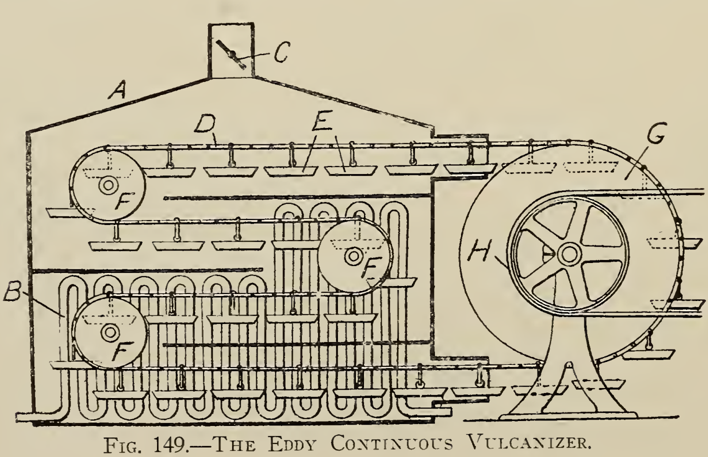


Fig. 149.—The Eddy Continuous Vulcanizer.

ting the mold in a vulcanizer or press, where it is left for minutes or hours, then taken out and opened. It has, however, long been the dream of manufacturers to have some sort of continuous process of vulcanizing where the goods pass from the making-up room directly into a vulcanizing mechanism, through it and on to the finishing department without interruption. This has been done in spreader work and in hose.

The Eddy Process.

Fig. 149 shows a continuous process vulcanizer for curing small goods. The vulcanizing chamber *A* contains steam coils *B* and a damper *C* at the top. A pair of endless chains *D* are connected by cross-bars with a number of perforated trays *E* hanging from them. The chains are driven by large sprocket wheels *G* and pass into the chamber *A* and around the three sprocket wheels *F*. Power is applied to the belt pulley *H* and the chains are driven as such slow speed that the goods in the trays are cured while passing through. The operator fills and empties the trays at the front of the sprocket wheels *G* while the machine is in motion.

Cold Cure Apparatus.

To show how proofed cloth is cured by a chloride of sulphur solution, Fig. 150 is added here. The roll of proofed cloth is placed

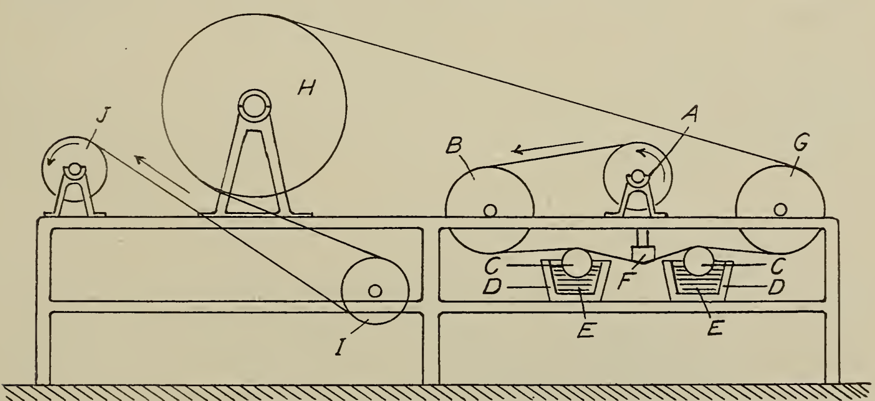


Fig. 150.—Cold Cure Apparatus.

in the machine at *A*. The fabric passes around the guide roller *B* and over rollers *C C* immersed in the vulcanizing solution *E E* in the lead lined troughs *D D*. By depressing the guide *F* the fabric is brought in contact with the vulcanizing solution. The treated fabric then passes over the guide roller *G* and around the heated drum *H*,

to hasten the evaporation of the solvent. After passing around the last guide roller *I* the cured fabric is wound up on the roller *J*.

The vapor cure is done in a great variety of dry heaters, large and small. A point of difference between the steam dry heater and the vapor cure chamber is the necessity for exhaust appliances in the latter, that the irritating fumes of the sulphur chloride may not injure the workmen.

The sun cure, or solarization, is not used on any considerable scale today. Twenty-five years ago, when "Gossamer" rubber coats were very generally worn, the sun cure was universal. The apparatus consisted of tables placed out of doors so that the rays of the sun fell

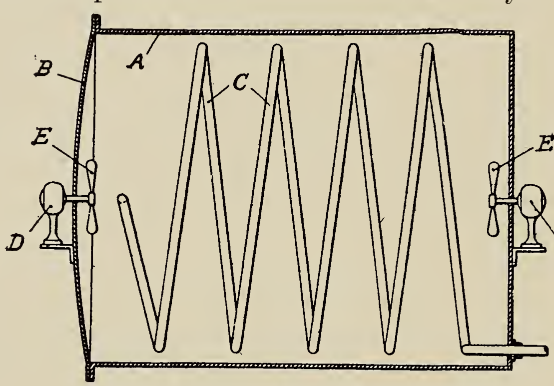


Fig. 151.—French Hot Air Vulcanizer.

directly upon the rubbered surface. If the sky was clear the cure was excellent. Vulcanization by dry heat, however, proved so much more reliable that in time solarization ceased to be employed.

French Hot Air Vulcanizer.

Fig. 151 shows a French type of hot air vulcanizer. The steel tank *A* is closed at one end and has a hinged door *B* at the other. Inside the tank is a steam coil *C* and at each end is a small electric motor *D*, driving a fan *E* on the inside to stir up the air and maintain an even temperature in the tank. A steam jacket may be substituted in place of the coils, and the fans operated by belts.

Repair Vulcanizers.

In the line of general vulcanizing comes the repair of small rubber goods. In tire repair the small vulcanizers are infinite in number and variety. For small general repair and experiment they are few. The apparatus shown in Fig. 152 is designed for use by dealers in rubber

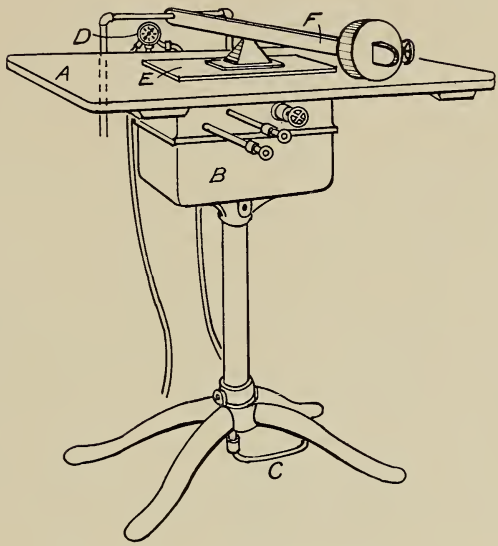


FIG. 152.—REPAIR VULCANIZER.

goods in repairing such small articles as hot water bottles, air bags, etc. The apparatus consists of a table *A* placed above a steam generator *B* which is heated by gas through the tube *C*. The generator is fitted with a gage *D* which regulates the gas supply so that the required steam pressure may be maintained for any length of time. The article to be vulcanized is placed between the table *A* and the plate *E*, the pressure being regulated by the weighted lever *F*.

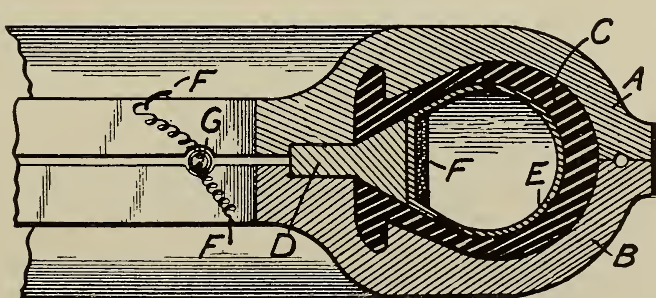


FIG. 153.—ELECTRIC VULCANIZER AND TIRE MOLD.

THE RIDDLE ELECTRIC VULCANIZERS.

Numbers of vulcanizers heated by electricity have been invented in the past but so far they are used chiefly in tire repair. The Riddle vulcanizer utilizes electricity both for heating the molds and holding them together in the place of the usual clamp. The principle of this invention was applied to a number of different forms of vulcanizers, three of which are illustrated and described herewith.

Referring to Fig. 153, *A* and *B* are two halves of a tire mold in which the tire *C* is placed with an annular key or ring *D* projecting through it at the base. Inside the tire is an inner tube *E* which is inflated to hold the walls of the tire against the mold. Inside the tube *E* is an annular electric coil *F*, which supplies heat for vulcanization. The ends of the coil pass out through the tire valve opening *C'* to the source of current.

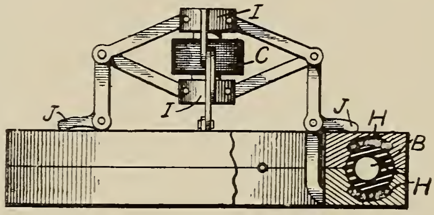


FIG. 154.

Fig. 154 shows an application of two electric coils in which one coil is used for heating and another for clamping the molds together. At *H* are shown the coils for heating the tire *B*. *C* is a solenoid or electro-magnet, which draws the plates *I* of the toggle joints together, forcing the levers *J* downward and clamping the mold together. In place of the heating coils, magno-thermal coils may be used both for clamping the molds together and for supplying heat.

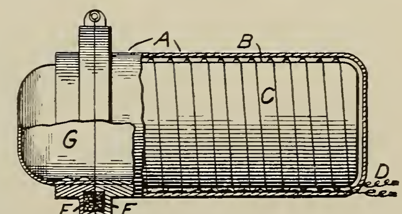


FIG. 155.

Fig. 155 shows the application of both heating and magnetizing coils to the horizontal type of vulcanizer. Between the shell *A* and

the lining *B* is a heating coil *C* connected with the source of current by the terminals *D*. The magnet coils *E* and *F* are placed in grooves in the door *G* and shell ring *A*, and when energized they hold the door tightly closed.

Sulphur Bath.

The sulphur bath for vulcanizing pure gum goods is a very simple contrivance. It is an iron vessel, lead lined, arranged so that it may be heated enough to melt the sulphur. It is also fitted with an exhaust hood to carry away and deposit the sulphur fumes. By keeping the sulphur molten and by occasionally removing the scum, continuous process vulcanization may be carried on as there is no opening or closing of heater doors. The goods after the cure must be treated with soda solution to remove the surface sulphur.

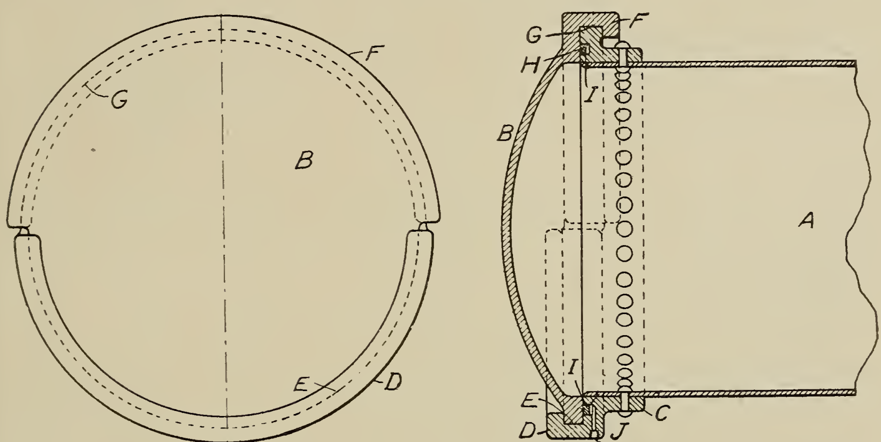


Fig. 156.—The Adamson Self Sealing Door.

Other special vulcanizers will be found in the various chapters devoted to their own lines of work.

Vulcanizer Doors.

Quick-closing devices for vulcanizer doors have come into vogue very generally in the past few years. The idea is not new, however. Dental vulcanizers by the score were long ago fitted with quick closing and opening devices. To an extent also in English, German and American factories, vulcanizers were fitted with variations of the simple hinged bolts. There were the bayonet lock idea, the wedge door, etc., etc. Ten years ago the veteran rubber manufacturer, Franz

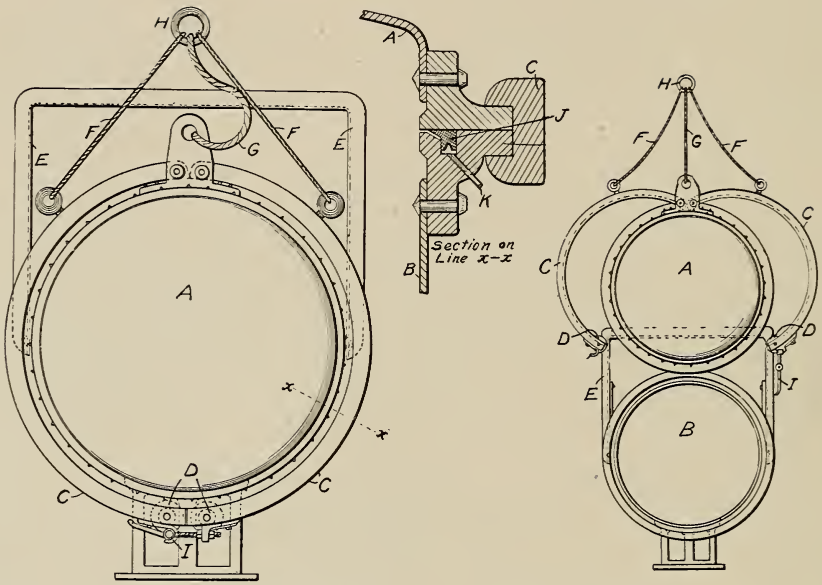


FIG. 157.—THE WILLIAMS QUICK-LOCKING DOOR.

Clouth, patented a system of bolts that fastened by wedge faces instead of screw threads. Some of the later and generally accepted forms of quick-closing doors are described below.

THE ADAMSON SELF-SEALING DOOR.

In the Adamson vulcanizer, Fig. 156, *A* is the shell and *B* the head. Extending from the lower half of the flange *C* is a lip *D* with a concentric groove *E*, into which the lower half of the door fits. On the upper half of the door is a similar lip *F* with a concentric groove *G* which fits into the upper half of the flange *C*. In the face of the flange *C* is an annular groove *H* containing a packing ring *I*. Through the opening *J*, steam or water under pressure is forced into the groove behind the packing. To close the vulcanizer the door is lowered into the grooves *E* and *G* and the steam or water pressure turned on behind the packing ring.

THE WILLIAMS QUICK-LOCKING DOOR.

Another quick closing and locking door is shown in Fig. 157. In this case the door *A* and shell *B* have flanges similar to those in which bolts are used, but the door is held to the shell by a pair of grooved semi-circular rings *C* which fit over the flanges when the door is closed. The rings *C* are hinged to the top of the door and have rollers *D* which

run on the vertical guides E when the door is lifted, thus forcing the rings outward and away from the flanges. The door and grooved rings are supported by cables F and G attached at their upper ends to the ring H. The cables F are shorter than G so that the rings C will be pulled outward away from the door, which is then lifted by cable G. To lock the door, it is lowered in front of the heater; the rings C join at the bottom and the lower ends are locked by a lever I. To seal the door, steam or water pressure is forced behind the packing ring J through the pipe K.

Hydraulic Door Closing Device.

In Fig. 158 is shown a German type of horizontal vulcanizer in which the door is hydraulically sealed. The head A and door B are

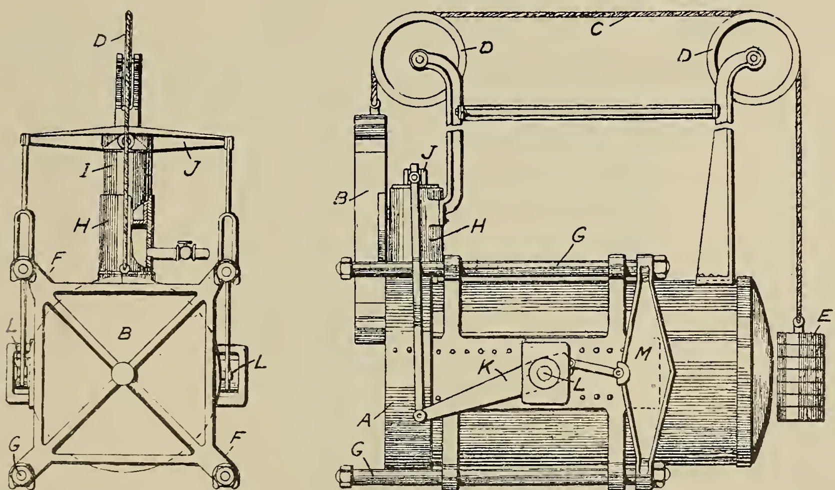


Fig. 158.—Hydraulic Door Closing Device.

planed off and fitted with a packing joint. The door is suspended by a cable C which passes over pulleys D and bears a counterweight E. The door is cast with projections F having slots which fit over the ends of the rods G when the door is in place. On top of the vulcanizer is a hydraulic cylinder H, the piston I of which bears a cross yoke J. This yoke is connected with levers K pivoted to the sides of the vulcanizer at L and operate the vertical yokes M. To close the door it is lowered so that the slots in the arms F fit over the ends of the rods G. Then water is admitted to the cylinder H, raising the yoke J and the levers K, and forcing back the yokes M and rods G. This forces the door tightly against the end of the heater.

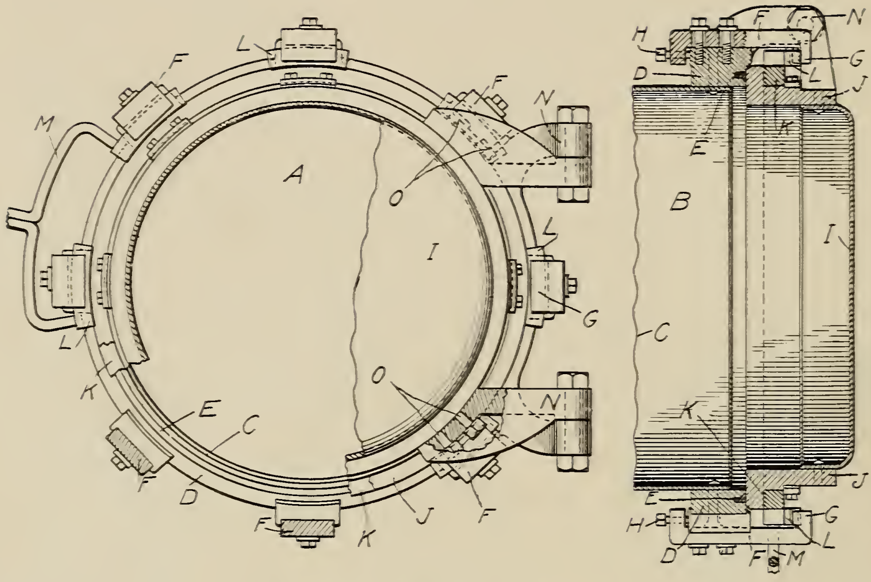


FIG. 159.—THE SHAW DOOR LOCK.

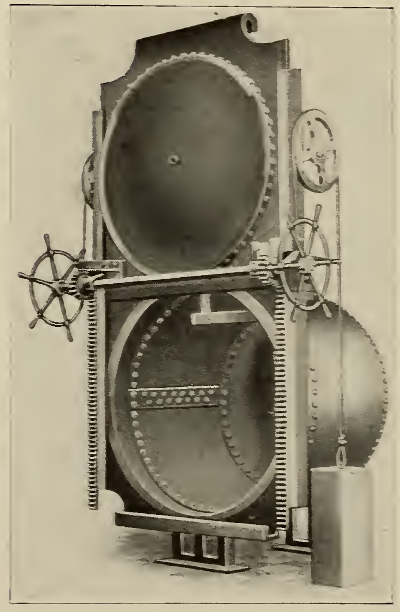


FIG. 160.—THE BRIDGE "AKRON-WILLIAMS" DOOR.

The Shaw Door Lock.

Another type of quick-locking door, designed by Shaw, is shown in Fig. 159. The drawing on the left shows the door in place, while on the right is a section through the center of the door and body. On the outer end of the shell *C* is a heavy ring *D* with a groove containing a packing ring *E*. The ring *D* supports eight thrust blocks *F* having wedge-shaped lugs *G* which are adjustable longitudinally by set-screws *H*. Riveted to the outside of the door *I* is a heavy ring *J* having a bearing upon which revolves the latch ring *K*. This has eight wedge-shaped blocks *L*, which engage the lugs *G* when the ring is turned by

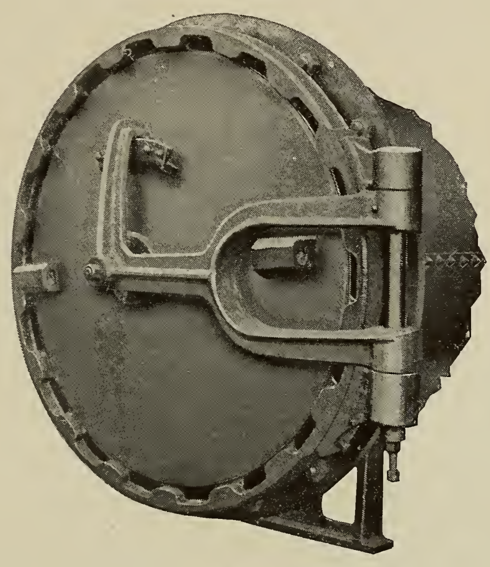


Fig. 161.—The Williams Boltless Head.

the locking lever *M*. The hinges *N* are attached to the door by adjustable bolts *O*, which allows the hinge connection to be made without binding after locking the door.

The Bridge "Akron-Williams" Door.

Fig. 160 illustrates a quick-closing door, which is raised and lowered by a rack and pinion movement operated by a pair of hand wheels. The door or "head" is counterweighted and slides in machined guides. The shell ring, against which it fits, has a circular groove containing a U-shaped packing ring with a wedge-shaped extension. Steam, air or water under pressure is admitted behind this packing, and forces it against the door, sealing the vulcanizer. When steam is

turned into the vulcanizer it presses the wedge extension of the packing ring against the inner face of the door, thus effecting a double seal.

The Williams Boltless Head.

This head, adapted to be attached to the bolted-on door to convert it to the quick closing type, is illustrated in Fig. 161. The shell ring to which the door is hinged is bolted to the old shell ring. The door rotates on a trunion at its center, supported by an adjustable bracket hinge. The shell ring and door have a series of projecting lugs and a wedged-shape packing ring. The door is turned by an iron bar forcing the door lugs under those of the shell ring. This locks the door and the internal steam pressure acting on the packing seals the joint.

The Allen Door.

A quick opening door that can be fitted to any vulcanizer door frame is shown in Fig. 162. It swings on a vertical axis, suspended

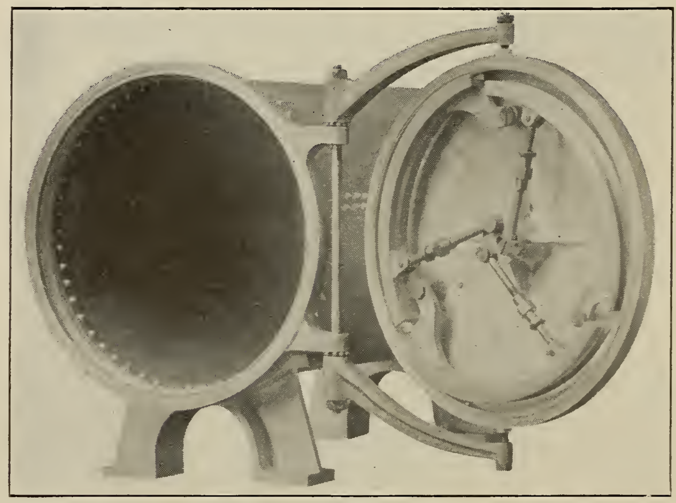


Fig. 162.—The Allen Door.

between two ball bearing arms which are hinged to the head flange. The door thus closes squarely against the packing. It is locked on the inside by three grooved segment rings, pivoted at one end and moved by tangent bolts attached to the free ends. The bolts are operated from the outside by turning a short shaft which projects through the center of the door.

CHAPTER X.

VULCANIZING PRESSES, SCREW AND HYDRAULIC.

THE simplest form of vulcanizing press is the small single screw press with one opening for molds, from six inches square and upward, with the upper and lower plates chambered for steam. This press is used for curing everything in the way of small mold work.

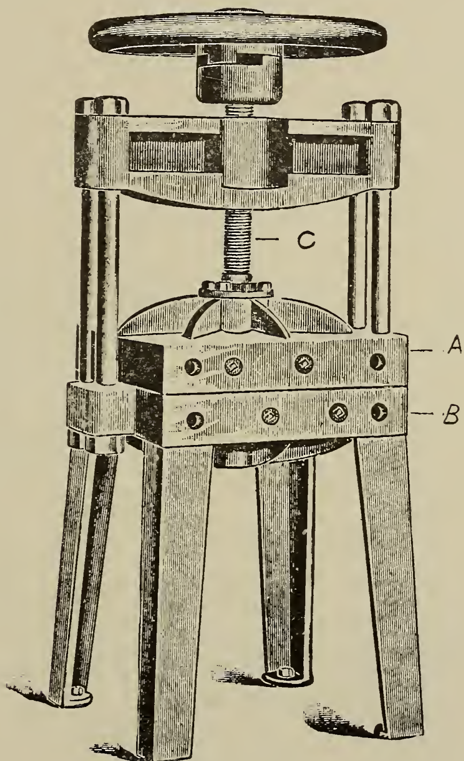


Fig. 163.—Knock Press.

This press is shown in Fig. 163. The two platens *A* and *B* are cored for steam and made sufficiently strong to withstand a pressure of 100 pounds per square inch. They are usually 12 to 15

inches square. The upper platen is suspended from the screw *C*, which is threaded through the upper part of the frame. The hand wheel is made heavy and has a clutch in the hub, enabling the operator to apply a series of hammer blows to the screw. For this reason it is known as the "Knock Press."

Small Standard Press.

The common form of 20 x 20-inch screw press has the following principal features: A lower steam platen which has a finished upper surface is supported by a frame or table. This platen supports four heavy bolts that carry the head and are rigidly attached to it. The upper movable steam platen has a finished under-surface and is attached to the lower end of the screw. This platen has offsets at the corners which act as guides. The screw passes through a threaded nut in the center of the head and is provided with a hand wheel at the top, by which the press is opened and closed.

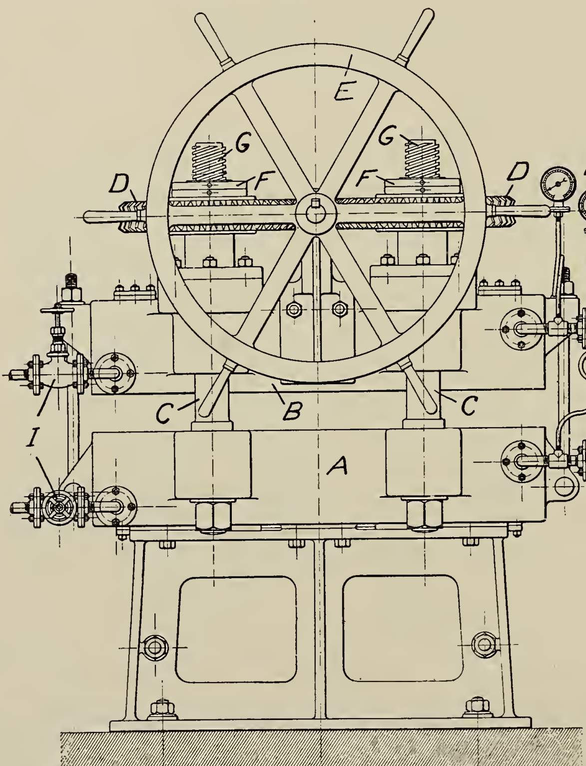


Fig. 164.—Double Screw Press.

Double Screw Press.

As a rule, screw presses are of small size, but by using two or more screws working through worm gears, large platens may be employed and considerable pressure exerted. The press shown in Fig. 164 is a German type in which high pressure is obtained by worm gears. Referring to the drawing, the lower platen *A* is stationary, while the upper platen *B* slides on the four columns *C,* and is raised and lowered by the worm gears *D,* which are turned by the hand wheels *E.* The worm gears turn the internally threaded nuts *F,* which fit the vertical screws *G* at the upper ends of the columns *C.* By this means the upper platen is raised and lowered. The platens are chambered for steam, with inlets *H,* outlets *I* and pressure gages *K.*

Toggle Joint Press.

Toggle joint presses are made in sizes from 12 x 14 to 66 x 72 inches. This type of press is shown in Fig. 165. It has three steam

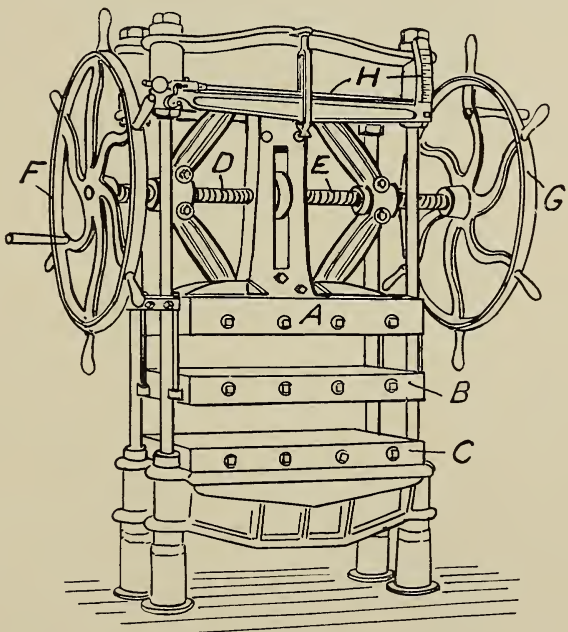


Fig. 165.—Toggle Joint Press.

platens *A, B* and *C,* the center one being suspended from the frame by adjustable bolts. The lower platen rests on a heavy base plate supported by four columns. The upper platen is raised and lowered by a pair of toggle joints operated by right and left-hand screws *D* and

E, and a pair of hand wheels *F* and *G.* The press has an indicator *H,* which shows the amount of pressure exerted on the molds between the platens.

Hydraulic Presses.

Hydraulic presses are made in standard sizes. Square presses with single rams are manufactured in the following sizes: 12, 18, 24, 30, 36, 40, 48, 52, 60 and 72-inch. A standard 36 x 36-inch square hydraulic press has one 12-inch ram which fits in a vertical cast iron cylinder having a base which supports the four steel columns. The top of the cylinder is counterbored to take a U-shaped packing and has a removable packing flange bored to the size of the ram and attached to the cylinder by bolts. The ram has a flange, which is bolted to the follower plate or lower steam platen. This platen is 36 inches square, five inches thick, and is chambered for steam. It is cast iron, with a smooth finish on the upper side, and has bearings for the columns to guide the platen as it is moved up and down by the ram. The top platen is fastened to the four steel columns which support it. It is finished on the under side, chambered for steam and has the same construction and dimensions as the lower platen. Both the top and follower platens have steam connections, and the cylinder has a hydraulic pipe connection and valve.

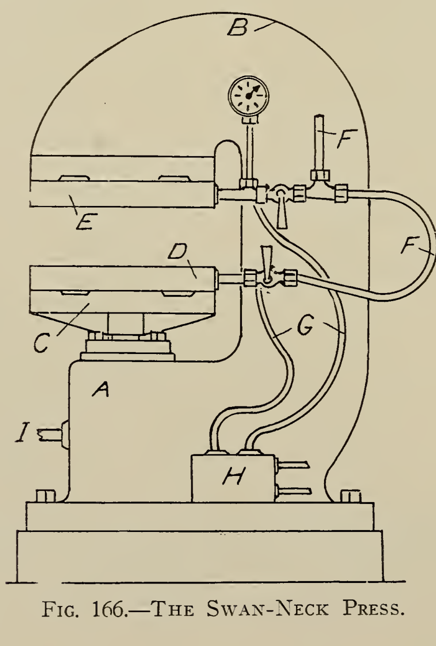


Fig. 166.—The Swan-Neck Press.

Single ram hydraulic vulcanizing presses are built with additional steam platens faced off top and bottom to form several vulcanizing spaces. These are termed multiple presses. In these the columns

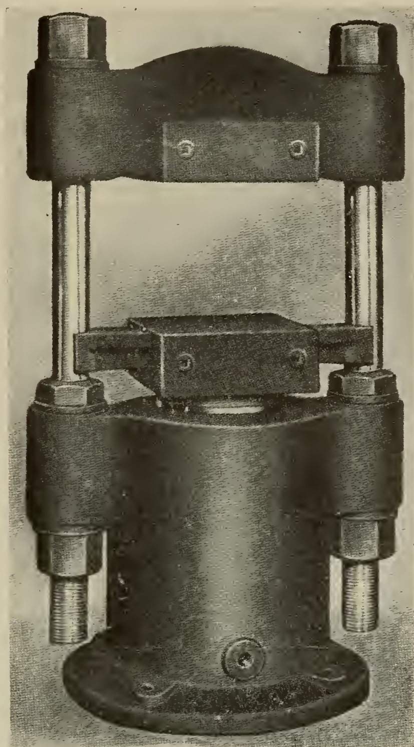


FIG. 167.—ADAMSON SINGLE RAM PRESS.

are made longer and the additional steam plates are held at fixed distances apart when the ram is lowered.

THE SWAN-NECK PRESS.

Fig. 166 shows a simple form of a small hydraulic press. The ram operates in the cylinder *A* which is cast integral with the frame *B*. On the head *C* of the ram is attached one of the steam platens *D*, while the upper platen *E* is attached to the frame. Steam is applied through the pipe *F*, and exhausts through pipes *G* and the trap *H*. Water for operating the ram is supplied to the cylinder at *I*.

THREE PLATEN PRESS.

This type is shown in Fig. 168. It has an adjustable platen *B* interposed between the platens *A* and *C*, which are supplied with steam

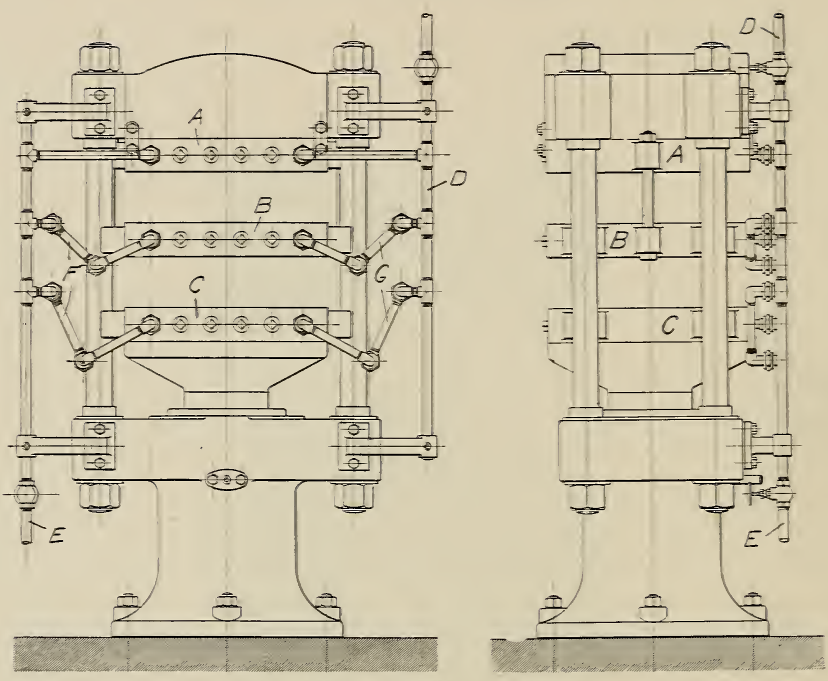


Fig. 168.—Three-Platen Press.

through the inlet pipe *D*. At the opposite side of the platens the steam exhausts through the pipe *E*. The pipes *F* and *G* supply steam to platens *B* and *C*, and have swing joints which allow them to be moved vertically. The heavy construction of the frame, plunger and bolts for the head, is typical of this type of press where very high pressures are obtained.

The Gang Press.

For vulcanizing long articles, such as rubber matting, sheet packing, belts and similar products, the gang press with continuous heating platens is used. In Figs. 170 and 171 the four separate hydraulic cylinders *A* are operated simultaneously from the single water line *B*. Attached to the heads of the plungers *C*, is a continuous platen *D*, which has a steam inlet and outlet at *E*. The upper heating platen *F* is also continuous and has a steam inlet and outlet at *G*. In order to move the article to be vulcanized in and out of the press, a traveling table *H* is employed. Extending along each side of this table is a toothed rack which engages a pair of gears *I* operated by the crank *K*. As the table is moved outward, it rests upon rollers *J* placed above the table *L*.

The Adamson Vulcanizer Press.

Fig. 173 illustrates a vulcanizer press in which the shell *E* is a steam chamber and also a support for the head. It consists of a lower flange *F*, a shell *E* and an upper flange *R*, which support the head *I*. The flange and head have lugs *H* and *J* which lock the head in place when it is given a turn. The joint is made steam tight by an expanding packing ring *K*. The uprights *L* support the head when raised and the chamber *E* is drained by the pipe *G*. The ram *A* operates in the cylinder *B* which has hydraulic connections at *C*. The upper end of the ram has a platen *D* that supports the molds. To operate the press, the ram is raised, lifting the cover, which then rests on the supports *L*. The ram is lowered as the molds are placed upon the platen, until the chamber is filled. The head is locked in place and live steam is turned on at *M*. The hydraulic cylinder is suspended in a well *N* and the press-vulcanizer rests on the floor.

The Fillingham Vulcanizer Press.

In the hydraulic press shown in Fig. 174 the head is forced down against the molds, while the platen which supports them is moved

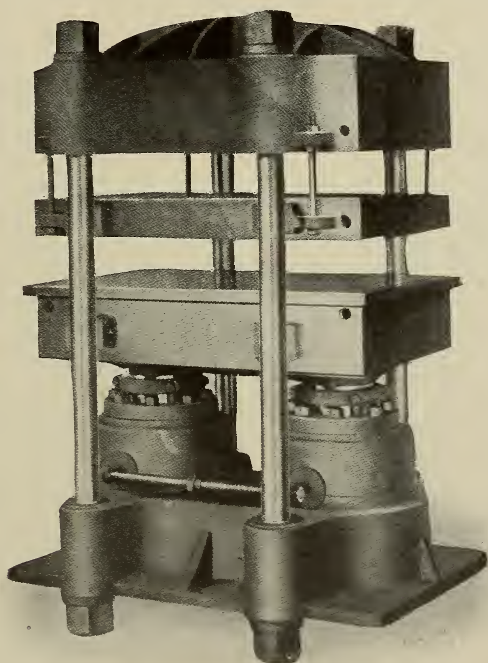


Fig. 169.—The Farrel Two-Ram Press.

independently of the head and the steam chamber. It consists of a hollow stationary column *C* bolted to a heavy bed plate. The stationary ram *D* is attached to *C*. The cylinder *E* has stuffing boxes at each end and reciprocates on *C* and *D* by hydraulic pressure applied at *F* or *N* acting on the head *D*. The bolts *S* are attached to *E* and their

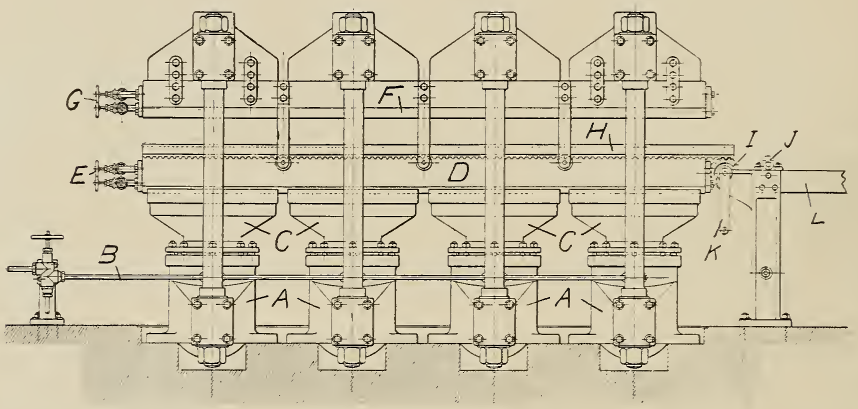


FIG. 170.—THE GANG PRESS.

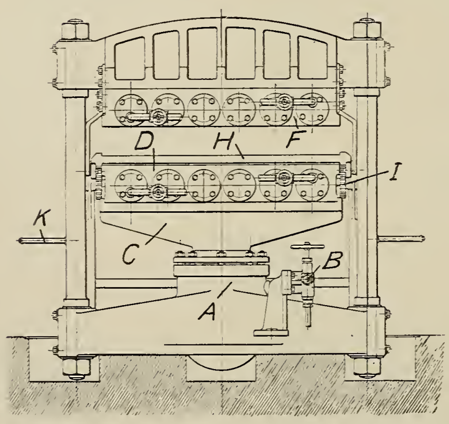


FIG. 171.—END VIEW OF GANG PRESS.

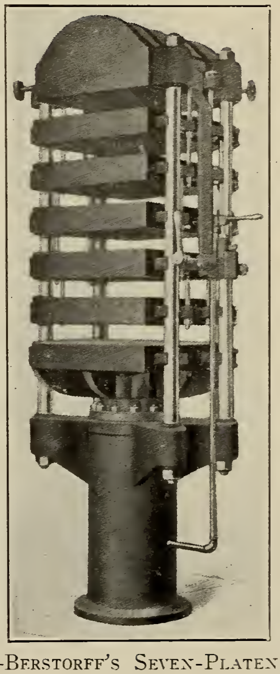


FIG. 172.—BERSTORFF'S SEVEN-PLATEN PRESS.

upper ends engage slots in the cover P. These slots open into holes through which the bolt heads pass when the cover is raised.

The steam jacketed chamber A has an upper flange L through which the bolts S pass. It moves vertically over the column C. On the upper end of this column rests a platen H which supports the molds I. It is attached to the upper end of a ram J which reciprocates in C.

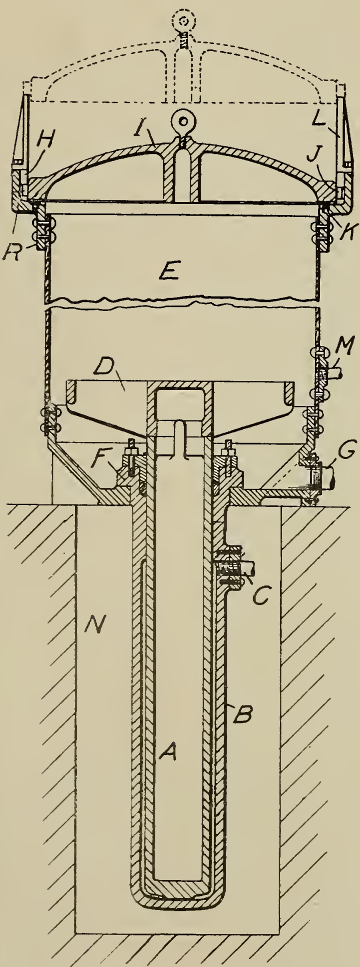


FIG. 173.—ADAMSON VULCANIZER PRESS

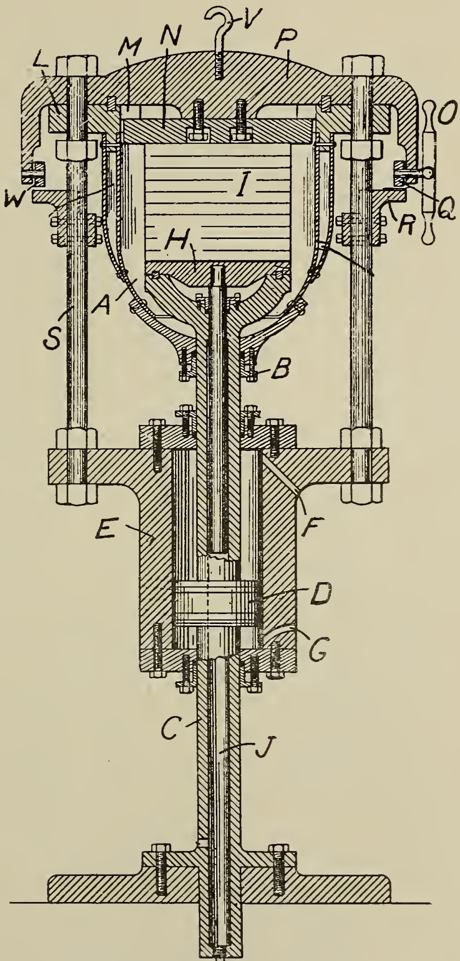


FIG. 174.—THE FILLINGHAM PRESS.

To operate, the cover P is turned by the hand wheel O which disengages the lugs M and clears the bolt heads so that the cover is

raised and suspended by hook V. Water under pressure is admitted at *G*, below *D*, forcing down *E* which lowers the chamber *A* until the platen *H* is exposed at the top. The molds are then placed upon it and water admitted at *F*, above *D*, which forces up *E* and raises the

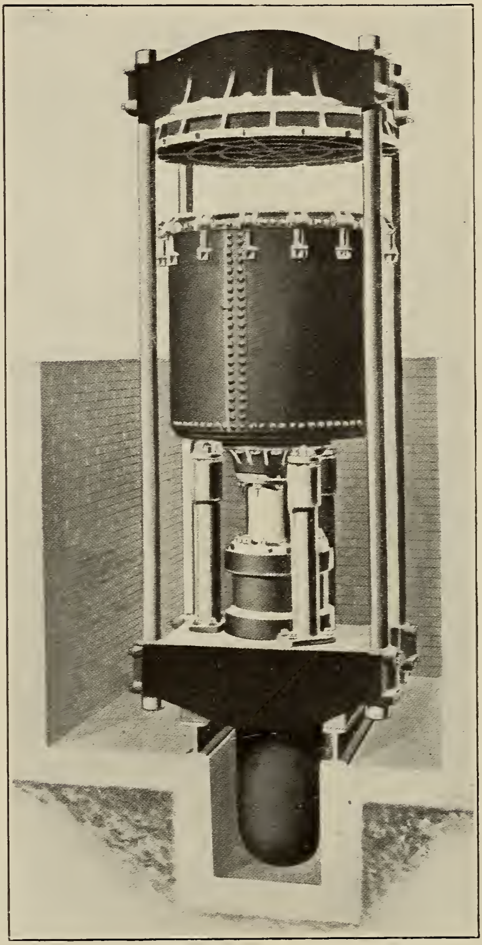


Fig. 175.—English Vulcanizer Press.

chamber *A*. The cover is then locked in place and the space between the molds and cover is taken up by operating the ram *J*. The downward pressure is then applied and steam admitted to the heater or jacket as desired.

THE SHAW HORIZONTAL VULCANIZER PRESS.

Another type of hydraulic press vulcanizer is shown in Fig. 176. It is used for curing solid tires made in straight lengths of about 15 feet. It may be used, however, for vulcanizing any kind of rubber

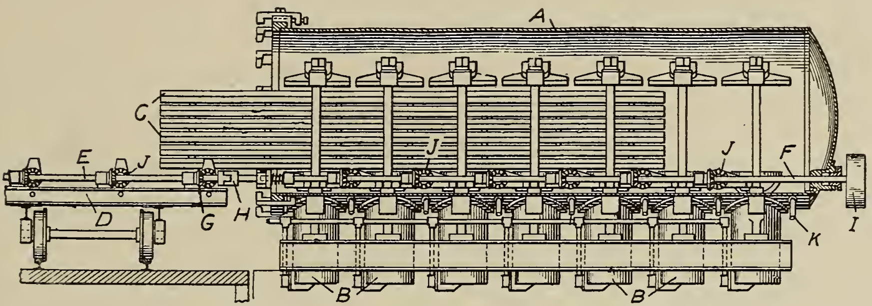


FIG. 176.—THE SHAW HORIZONTAL VULCANIZER PRESS.

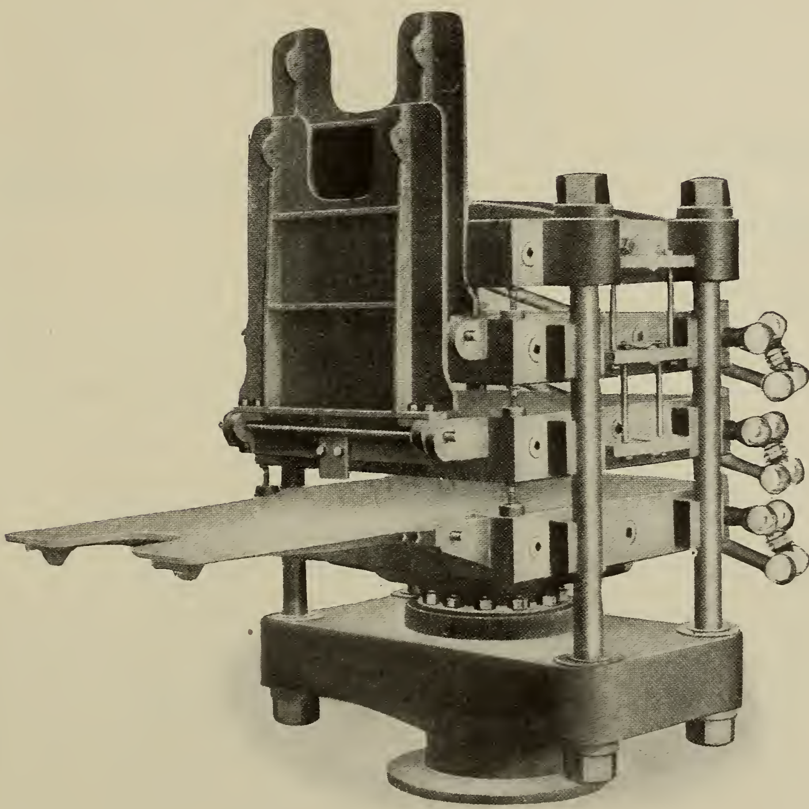


FIG. 177.—THE PERRIN HINGE TABLE PRESS.

goods that require long molds. It comprises a horizontal shell *A*, seven hydraulic rams *B*, six long molds *C* and power driven rollers for conveying the molds into the cylinder. The rams are all operated from a common water line so that they work in unison. The molds *C* are lifted on a car *D* (only part of which is shown) and moved to the front of the heater, and the shafts *E* and *F* are coupled by the jaw-clutch *H*. The bevel gears *G* drive a series of horizontal rollers *J*, so that when the shafts are rotated by the belt pulley *I*, the molds are run into the press. The molds, which are separated to allow circulation of steam around them, are then subjected to heavy pressure by the hydraulic rams, after which steam is admitted through inlet pipes *K*. After vulcanization the shafts *E* and *F* are reversed and the molds run out.

Hydraulic Accumulators.

It is common practice to have in the hydraulic system an accumulator for storing water pressure. It regulates the action of the pump

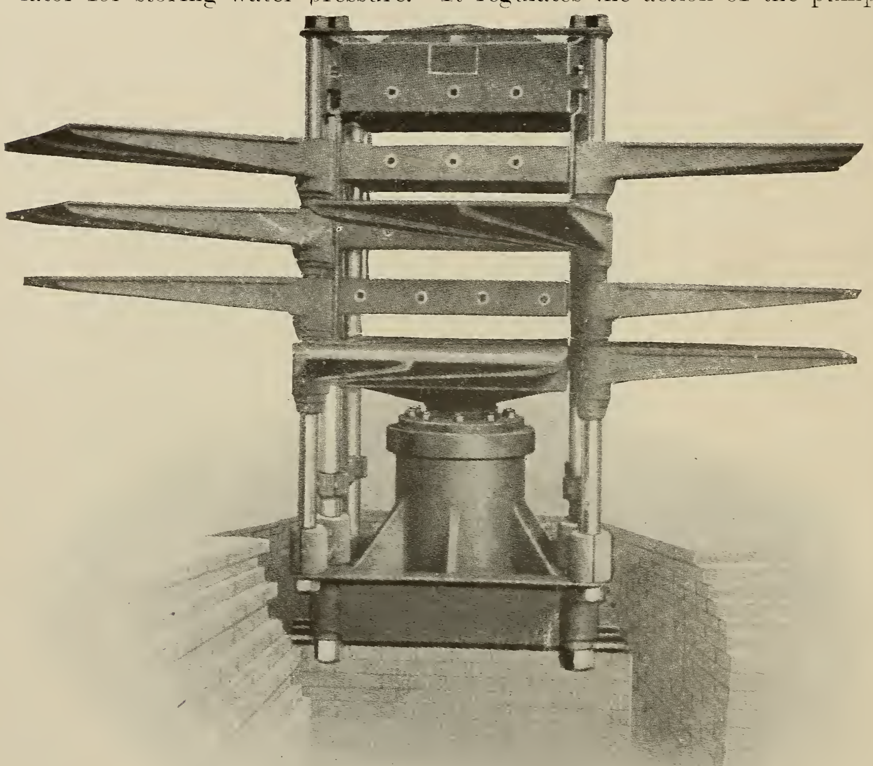
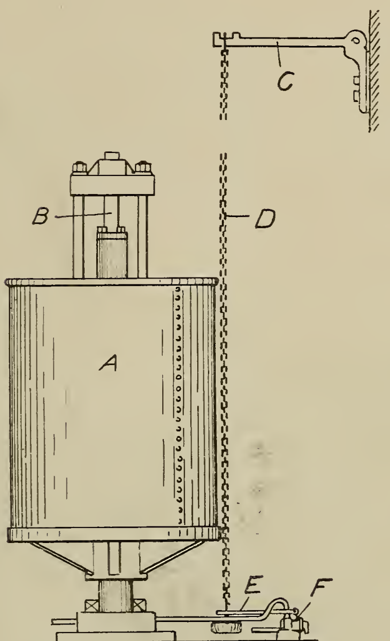


Fig. 178.—The Thropp Swing Table Press.

and keeps the water pressure constant. It is more economical to employ a small pump working under a uniform pressure all the time than a large pump part of the time. For low pressure, a tank placed at a certain height above the work will give sufficient pressure. But to supply high pressures by gravity only would require a tank a quarter of a mile high, and for this reason the accumulator is employed.

It is a vertical cylinder closed at one end and having a ram working through a stuffing box. The ram carries a load of iron weights



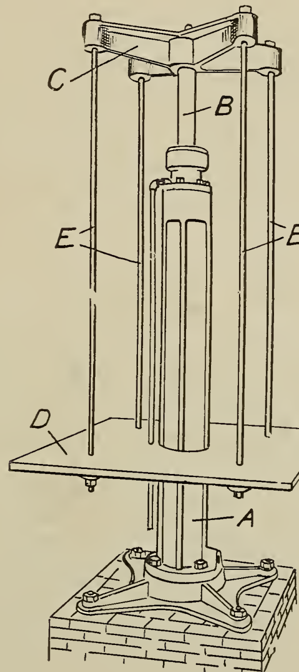


Fig. 179. Accumulators. Fig. 180.

on a platform suspended from its head. Sometimes a tank is employed, into which slag, stones, brick, etc., are thrown to make up the required weight. The accumulator should be placed as near the pump as possible. The intensifier is a modified form of accumulator. It consists of a piston operating in a cylinder, the piston rod passing through a stuffing box in the top of the cylinder, and working in a second smaller cylinder above the main cylinder. Water enters the larger cylinder and forces up the piston working upon the upper small piston.

The intensified pressure is delivered from the small cylinder. The ratio of areas of the two pistons gives the degree of increase of pressure produced.

Fig. 179 shows an accumulator with a tank *A* for containing weights. When the plunger *B* reaches its maximum height, the edge of the tank, *A* lifts the lever *C*, and by the chain *D* the lever *E* is also raised. This closes the valve *F* and stops the pump until the amount of water in the accumulator is reduced by use, when the pump starts again.

Fig. 180 shows another form of accumulator, in which *A* is the cylinder, *B* the plunger and *C* the crosshead from which a platform *D* is suspended by four bolts *E*. Upon this platform are placed the required number of iron weights. When the plunger reaches a certain height the crosshead strikes against a stop attached to a chain and closes a valve placed in the line between the pump and the accumulator. This stops the pump until the amount of water in the accumulator is reduced sufficiently to allow the valve to open.

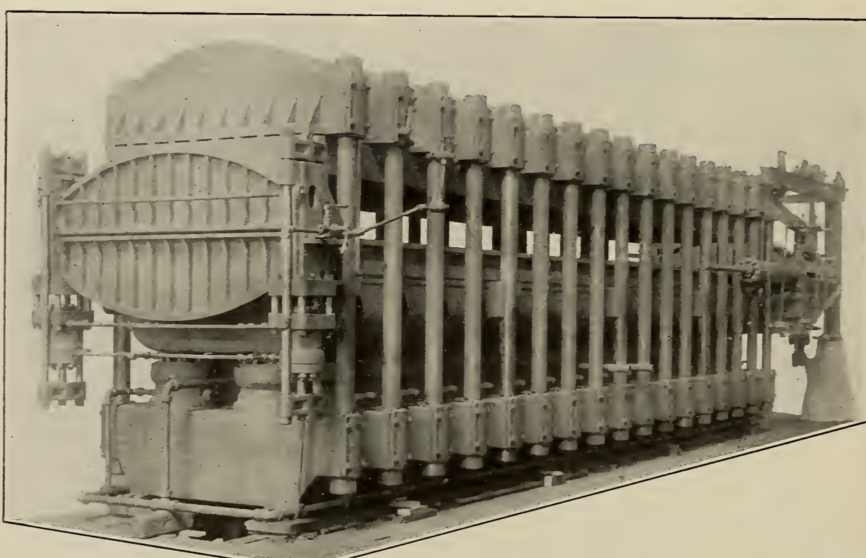


Fig. 181.—Farrel Multiple Ram Belt Press.

CHAPTER XI.

TUBE MAKING MACHINERY.

RUBBER tubing for many years was made wholly by hand. It ran in length from 18 inches up to 15 feet. The hand process was as follows:

The stock for the tubing was calendered quite thin on cotton sheeting, which, as fast as spread, was wound upon a wooden shell. The table upon which the tubing was made was zinc covered and very smooth and level. The roll of sheet rubber hung in a rack consisting of two uprights, with bearings for a horizontal bar running through the shells. The foreman of the tube makers with a clean, square stick, a trifle longer than the width of the sheet, drew a sheet of rubber off the roll upon the table while one of his assistants wound the cotton sheeting off upon the second shell. The sheet of rubber was cut off the roll, leaving it a little more than 15 feet in length. The tubemakers then gathered in their places, all on the same side of the table, the cutter standing farthest from the roll. The further edge of the rubber sheet was secured to the table to prevent slipping.

The mandrels or wires, which formed the cores of the tubes, were laid upon a table at the back of the workers. They were previously treated to a coating of soft soap, and dried, after which a light coating of cement made of mixed sheet and naphtha was brushed over them. A wire was laid upon the edge of the sheet, which had previously been trimmed by the cutter. The four tube makers struck it gently to stick it to the sheet. It was then raised free from the table and the sheet rolled around it three or four times, gages in the hands of the workers determining its size. The cutter then, wetting his blade, went to the further end of the table and walking backwards, by a single long sweeping stroke cut the tube free from the sheet. After being rolled forward and back several times, and possible blisters pricked, the tube was deposited upon the rear table, which was upholstered with a mattress of cotton cloth to prevent the unvulcanized rubber from flattening. The same process was repeated until the entire sheet was used.

Then came the wrapping of the tubes in cloth. Long strips of cambric, muslin or other fine cloth were wet and laid upon the rear

table. The end men, taking the top strip, lifted it over and stretched it upon the zinc table. A tube was then laid upon the cloth, the edge lapped over it, brushed down with the fingers, drawn tight, and with a quick roll wrapped securely. The wrapper was further tightened by rolling, either with four short boards, or with one long, fifteen-foot board. An iron pan, upon which was laid a thin mattress of coarse cloth, received the tubes for the vulcanizer. They were packed in layers, three—sometimes four—deep, depending upon the size of the tube and the weight of the mandrel.

This process was so slow that it was soon superseded by the mechanism known as the tubing or spewing machine. Briefly described, this consists of a horizontal cylinder, jacketed to hold steam. Fitting this cylinder is a powerful worm or archimedean screw, and at one end of the cylinder is an opening into which the rubber is fed. At the other end is a die through which the screw forces the plastic rubber.

The principle upon which the first rubber tubing machine was constructed is still followed. The application, however, is so much better understood and so many changes have been made that the latest tubing machines so far excel them in productive capacity and general usefulness that the change from the old machine to the new is of more economic importance than the first radical change from hand work to machine manufacture. For example, with a single perfected tubing machine, it is possible to make plain, corrugated and soapstoned tubing, solid cords, wagon tires, multiple tubes, wire and fabric insulation, etc.

Standard Tubing Machines.

A modern tubing machine of the standard type may be described as follows:

The horizontal cylinder is solidly attached to a cast iron stand or pedestal. The inside is smooth finished and is usually lined with a bushing which can be replaced when worn. The cylinder is chambered for steam and water for controlling the temperature. At its rear end is a solidly fastened bearing to withstand the heavy end thrust of the stock worm.

The stock worm is a spirally grooved arbor working inside the cylinder, which kneads the rubber compound and forces it forward. Projecting through the thrust bearing, it extends beyond the machine to carry the driving gear. At the front end of the cylinder is attached the stock head, holding a removable die which forms the outside of the tube and also a guider for forming the inside of the tube. This stock head is also chambered for steam and water circulation. There is also

attached to the frame of the machine an adjustable bracket. which supports on a roller the driving end of a delivery apron. This apron carries the tube away from the machine as it comes from the stock head.

These machines are also built with a cylinder to hold powdered soapstone, with inlet and outlet for an air pipe which conveys the powder up through the machine head and to the inside of the tube. The dies and girders for forming the tubing are removable.

Fig. 182 shows a longitudinal section of a tubing machine. The important parts are the steam chambered cylinder *F;* the worm *L,* with

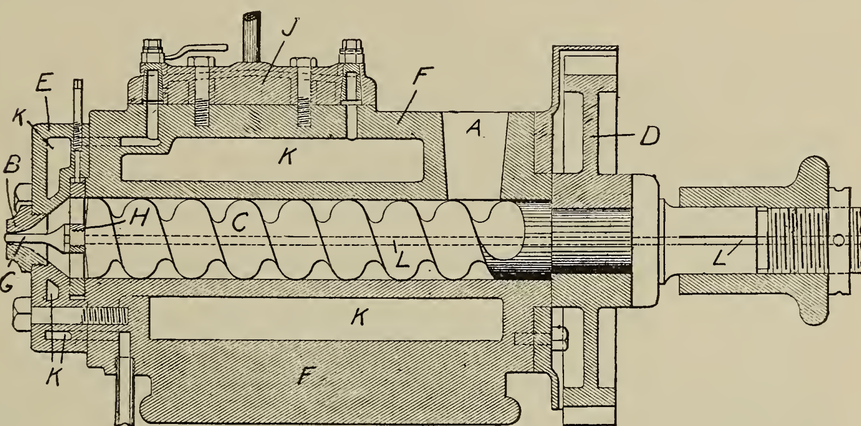


Fig. 182.—Standard Tubing Machine.

its thrust bearing shown at the right hand end; the head *E;* the die *B,* and the core *G.* The rubber is fed through the opening *A* and is forced forward to the die *B* by the screw *C,* which is revolved by the gear *D.* The head *E,* to which the die is screwed, is bolted to *F.* A core *G,* fixed to the adjustable bridge *H,* projects into the center of the die. Steam or water is admitted to the chambers *K* in the screw casing and the die holder.

The Royle Tubing Machine.

Fig. 183 shows one of the later types of American tubing machines, equipped with motor drive, heating and cooling compartments, soapstoning tank and adjustable take-off mechanism. This machine, with various types of dies and die holders, is used for making rubber tubing, insulated wire, jar ring tubes, solid tires, and also for covering tubular fabrics. The head *A* and cylinder *B* are similar to those parts shown in Fig. 182. The machine is driven by a motor *C* through a

pinion D driving a spur gear E journaled in the housing F. A pinion on this shaft revolves a large gear keyed to the worm shaft. The driving gear is enclosed by a guard G to protect the operator.

Tubing, as it issues from the die, is soft and liable to injury. Until vulcanized it must be handled with care to avoid stretching or deforming. The tube is therefore delivered upon a horizontal belt running over a pulley H directly in front of and slightly below the

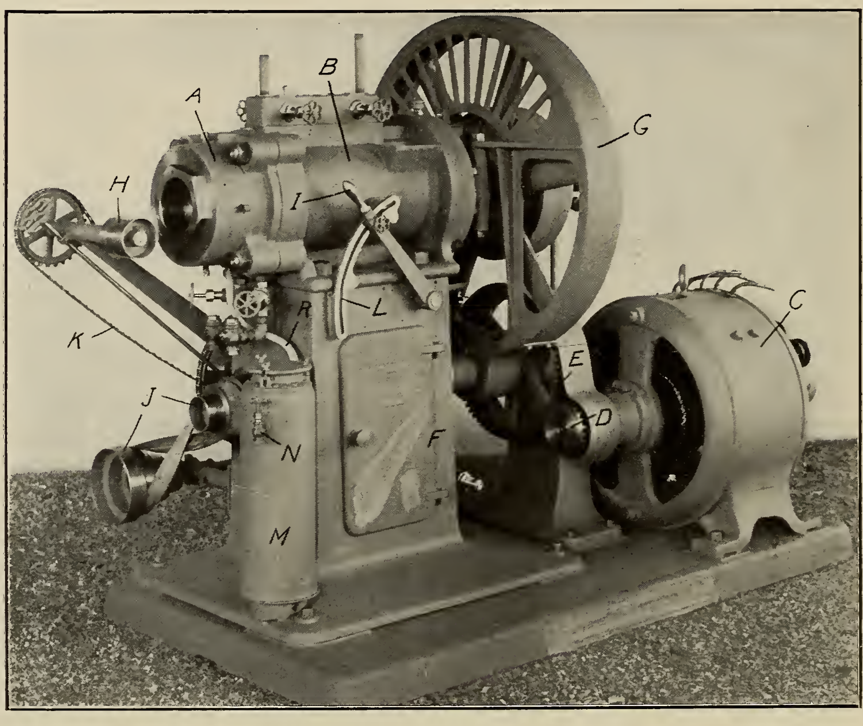


FIG. 183.—THE ROYLE TUBING MACHINE.

die. The pulley H is provided with a speed regulating machanism controlled by the hand lever I. Power for driving the apron is taken directly from the driving shaft extending through the housing F.

To prevent the tube from collapsing and the inner walls from adhering to each other, powdered soapstone is forced into the tube as it is formed by compressed air. The soapstone is placed in the tank M, which has an air inlet N and a tube R for conveying the soapstone to the

die. The tank is only partly filled with soapstone, leaving a generous air space. As the soapstone mixes with the air it is carried to the die and blown into the tube as it is formed.

Motor Drive.

As in other branches of the rubber industry, motors are fast taking the place of belts for tubing machines. The best method is to make the motor and machine a unit by mounting both upon a sub-base and driving through positive gearing from the motor to the driving pinion of the machine. The sizes of motors vary. For the smallest machine, making tubing ½ inch in diameter and under, a motor of 2 to 4 horse-power is required; for a machine making tubes up to 1 inch in diameter, a 5 to 8 horse-power motor is employed. Machines making tubes up to 3 inches in diameter require a 15 to 18 horse-power motor. Larger machines, for jar ring stock, solid vehicle tires and large sizes of hose lining, require a 20 to 25 horse-power motor.

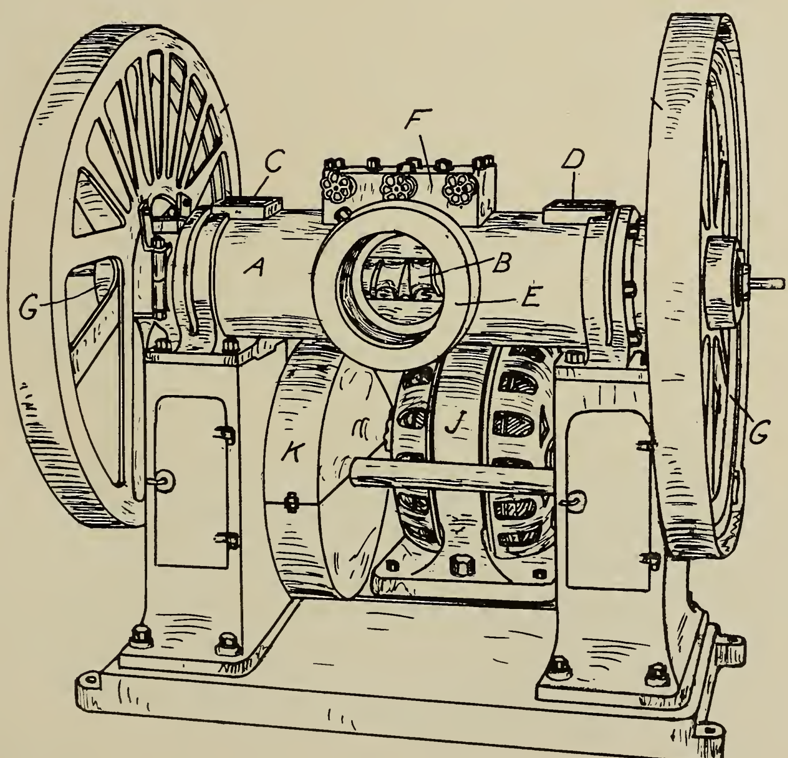


Fig. 184.—Allen Double Tubing Machine.

The Allen Double Tubing Machine.

The Allen machine, shown in Fig. 184, is really two machines in one, the cylinder *A* containing a right and left worm *B*. When rubber stock is fed into openings *C* and *D*, the worm forces the stock to the center and out through the die in head *E*. A chest *F* provides steam and water connections for heating or cooling the stock as it passes through the chambered cylinder. The shaft of the worm extends through the end bearings and carries a fly wheel *G* at each end. The worm is bored for water circulation. The machine is driven by an electric motor *J* through reducing gears, which are enclosed in the case *K*.

The Kay Tubing Machine Feeder.

Fig. 185 illustrates a tubing machine equipped with a pair of feeding rolls, which force the rubber into the cylinder more quickly

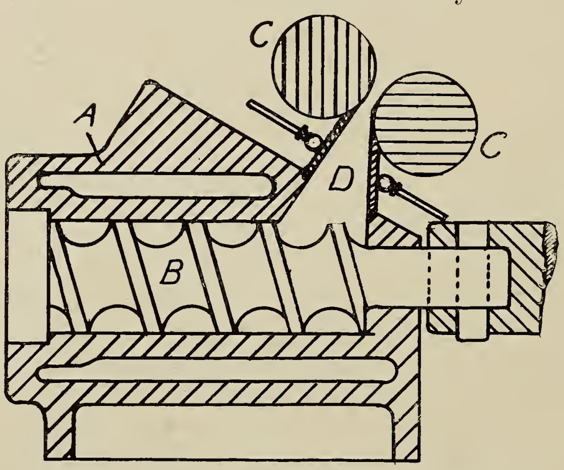


Fig. 185.—The Kay Tubing Machine Feeder.

and under pressure. The cylinder *A* and feeding screw *B* are practically the same as in the ordinary tubing machine. The feed rollers *C* are placed on the cylinder above the feed opening *D* and are inclined at an angle of about 30 degrees to the horizontal, to reduce friction. The hopper *D* is made equal in length to the diameter of the cylinder *A* and equal in width to the pitch of the worm *B*, thus providing uniform feeding.

The Mahoney Striped Tubing Machine.

Fig. 188 shows a device for making striped tubes. The machine has an outer cylindrical shell *A*, within which a sleeve *B* rotates. This

sleeve has a continuous spiral feed channel C. Within it is a second spiral feeder D, these two being separated by a sleeve E. A chamber G receives the rubber compound forced into it from the groove C. A chamber H receives the compound from the spiral feeder D. The die I is in the form of a plug with ribs which make it fit into the opening in the center of the die carrier. This leaves a space between these two parts, divided by the projections on the die and in the holder. Extending from the outside of the cylinder to the center of the die holder are four stems J. These have bevel gears M on their outer ends and are rotated by the bevel gear K on the outside of the casing. On the inner end of each stem is a stripe forming die projecting into the opening between the die holder and the die. Each of these stems has an aperture which, in a certain position, forms a continuation of the opening G from the feeder B to the die.

Compounds of different colors are placed in hoppers and forced into the chambers G and H. Strips of one color are forced from the chamber H through the openings between the ribs of the die; strips of a different color issuing from the chamber G filling the spaces between the first set of strips. Thus, the machine assembles strips of

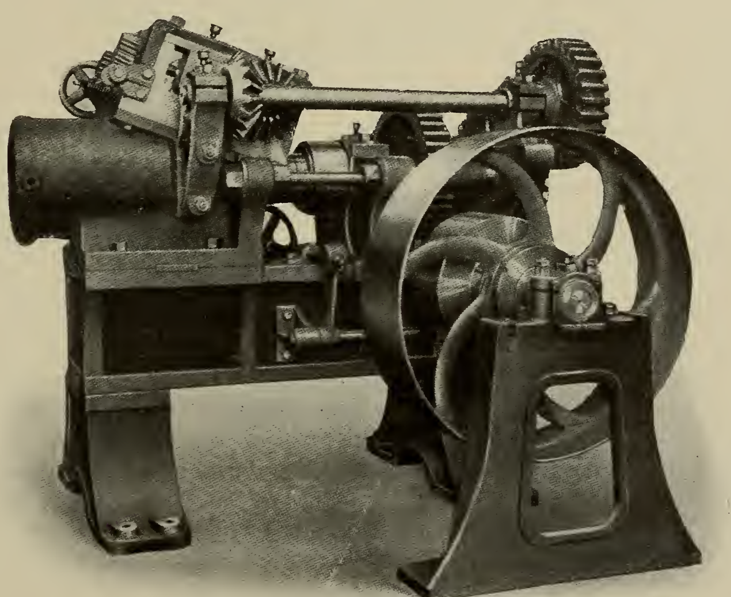


Fig. 186.—Tubing Machine with the Kay Feed.

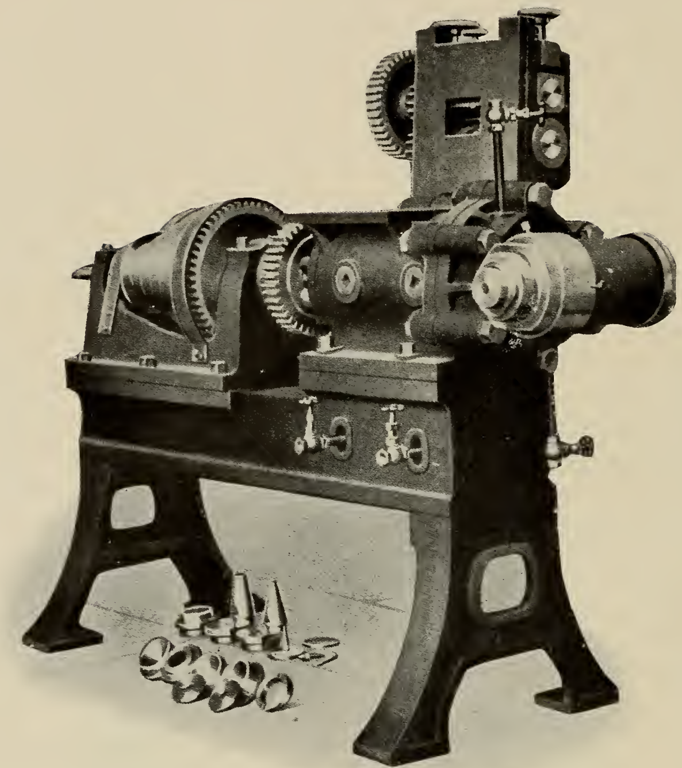


FIG. 187.—THE BRIDGE TUBING MACHINE FEED OPEN.

compound of different colors, adhering at their edges to form a complete tube. To produce stripes with a wavy effect, the feeders are mounted so as to oscillate on their axes.

THE VOORHEES TUBING DIE.

In the manufacture of cheap tubing, particles of metal sometimes form defects or leaks. This is prevented in the die illustrated in Fig. 189. The drawing on the left is a longitudinal section of the head of a tubing machine. The lower drawing on the right is an enlarged section through the die, while the upper drawing is a cross-section. *A* is a worm which revolves in the cylinder *B*. *C* is a steam-jacketed head attached to *B*, supporting the die. *D* is a core-sustaining bridge fitted to the head *C*. This core-holder has a hub, connected to its outer rim by three arms, providing spiral passages for the rubber compound. The die *E* is held in position by the spacing block *F* and the nut *G*,

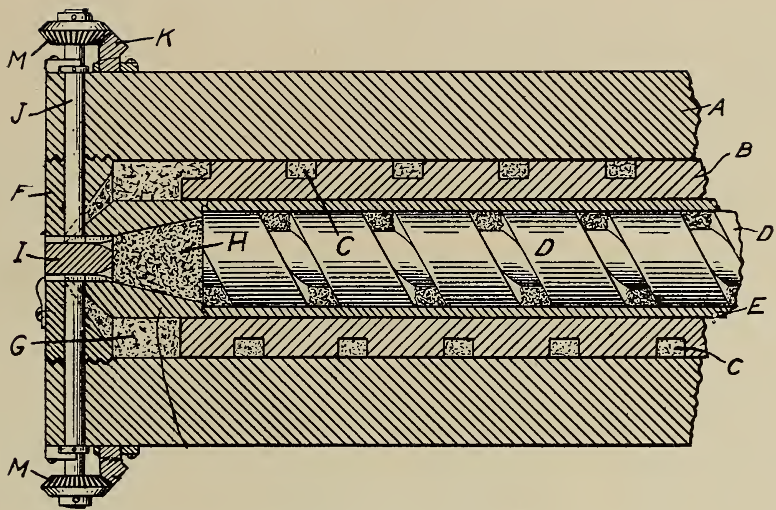


FIG. 188.—THE MAHONEY STRIPED TUBING MACHINE.

these parts being centered by set screws *J*. A core *H* is screwed into the core-holder *D* and projects into the die *E*. A tapering circular thimble *I* is located in the passage through the forming die. This thimble divides the rubber compound as it is forced through the die, forming two tubes. After passing the thimble the two tubes are united

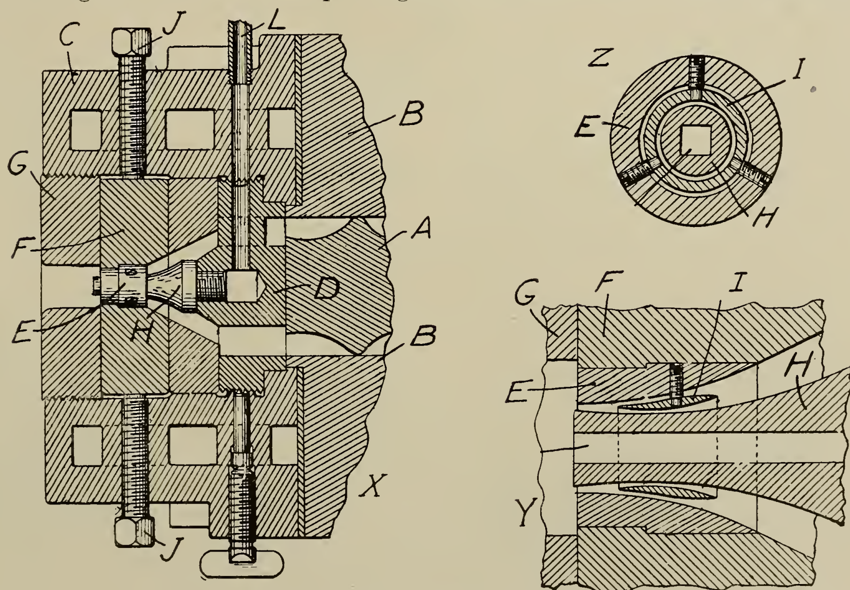


FIG. 189.—THE VOORHEES TUBING DIE.

into one. Any particles of foreign material are thus confined to the inside or the outside tube and cannot extend more than half way through the total thickness of the finished tube.

The Dewe Hammering Machine.

The machine, illustrated in Fig. 190, forms a strip of sheeted rubber into a seamless tube by drawing the edges together over a mandrel and joining them by a series of rapid blows delivered by a small trip hammer. With freshly cut stock a seam may be made without

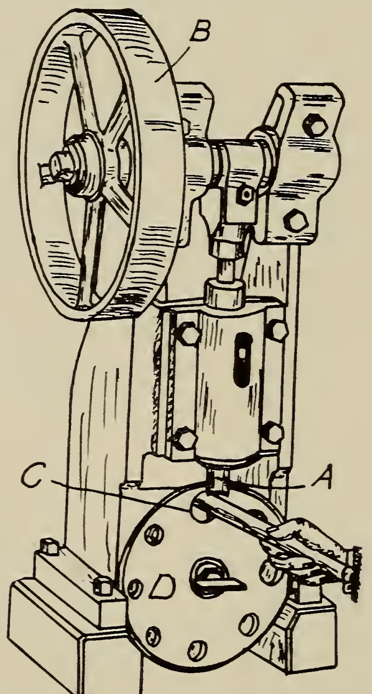


Fig. 190.—The Dewe Hammering Machine.

cement which will withstand as much strain as any other part of the tube. The machine will produce either butt or lap seam tubes. The tube is started over the mandrel by hand and the hammer *A* set in motion through belt pulley *B*. As the hammer welds the seam, the tube is pulled through *C* in the plate *D*. This plate has eight openings for tubes of as many different sizes, and other plates may be substituted for other sizes of tubing. The machine shown occupies a space about a foot square and stands about 26 inches high above the table.

THE TURNER TUBING MACHINE.

The Turner machine for forming a strip of sheeted rubber into a tube and cutting it into lengths, is illustrated in Fig. 191. Strips of rubber of a proper width, and with edges solutioned, are fed into the

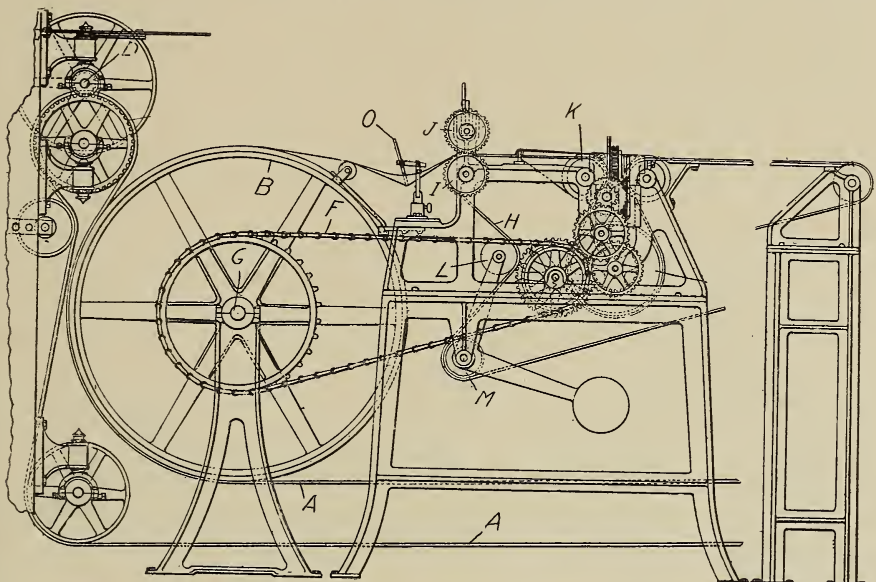


FIG. 191.—THE TURNER TUBING MACHINE.

machine on the upper surface of the belt A. They are passed around the drum B, through a closing die at O, where the edges are abutted, closing the strip into a tube. The tube then passes through the presser-rolls I and J, which roll the seam down. From the presser-rolls it is fed to the cutters Q, which are operated intermittently by cams and cut the tube into the required lengths. From the cutters the tubes are carried forward upon the belt H to any convenient point.

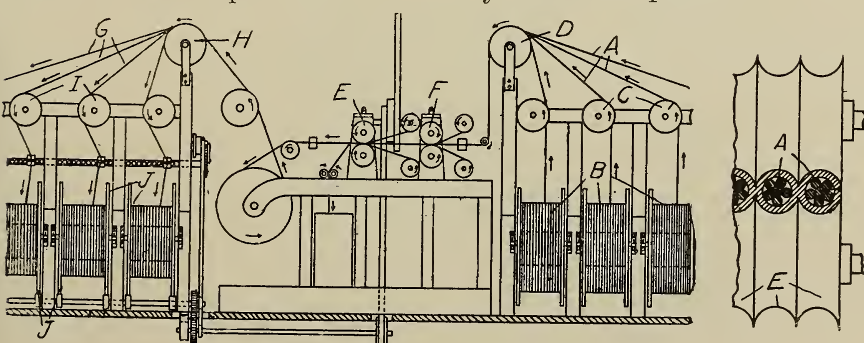


FIG. 192.—MULTIFLE TUBE MACHINE.

Multiple Tube Machine.

The machine shown in Fig. 192 forms a number of tubes on wire cores at one operation. The wires *A* are drawn off from the reels *B* and pass over the guide pulleys *C* and *D* to the grooved rollers *E* and *F*, several wires being used in each groove to form the complete core. The rollers *E* and *F* have a number of grooves of suitable size for the outside diameter of the tubes to be formed. The cores *A* and the upper and under covering strips of rubber pass through the grooved rollers *E* and *F*. This presses the upper and under strips firmly together, resulting in a series of tubes, each surrounding its core. The

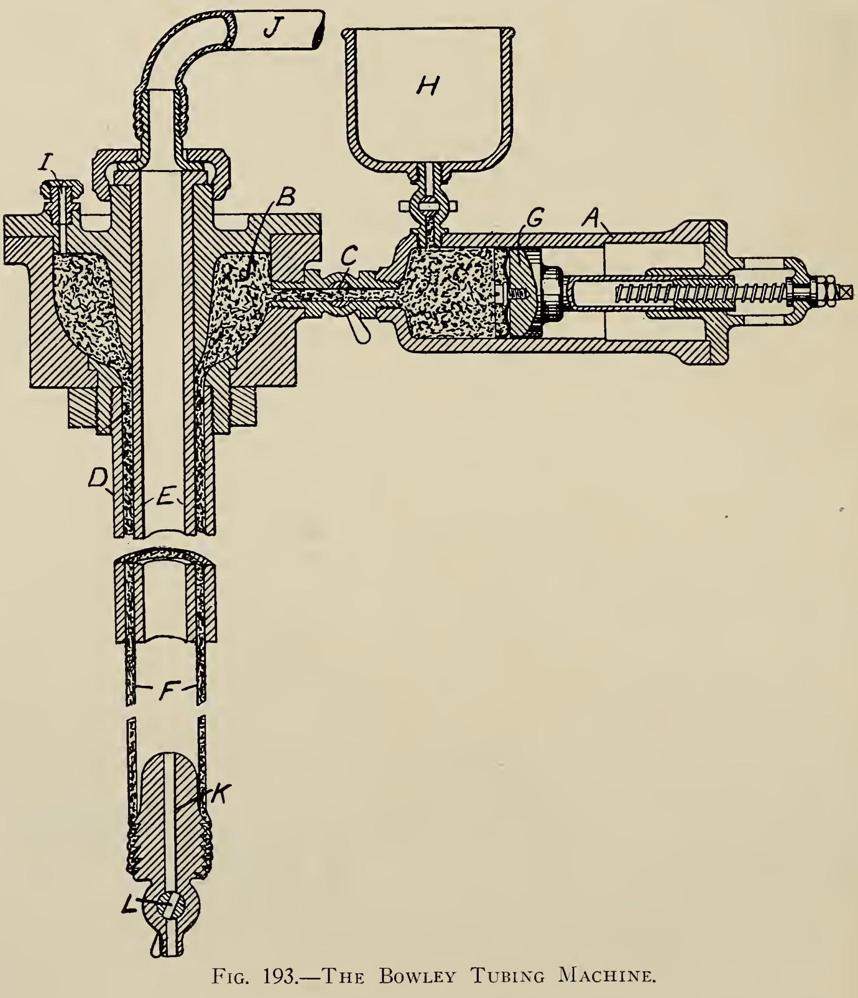


Fig. 193.—The Bowley Tubing Machine.

tubes *G* thus formed are guided over the pulleys *H* and *I* to take-up drums *J*. They are then vulcanized, after which the wire cores are withdrawn. The upper and under strips should be of the proper width to extend over all the cores and fed in a single sheet. The drawing on the right of the rollers *E* shows the wire cores *A* and the method of pinching the edges of the rubber strips together to close the seams.

The Bowley Tubing Machine.

Fig. 193 relates to a method of forming rubber tubing and curing it by the cold-cure process. It consists first in dissolving rubber in bisulphide of carbon and adding chloride of sulphur. The drawing shows an apparatus for producing rubber tubing from this solution. The mixture is compressed in the cylinder *A* and forced into the chamber *B* through the stop cock *C*. As the rubber is compressed in *B* it is forced downward between the die *D* and the core *E*, thus forming the tube *F*. When the piston *G* reaches the end of its stroke the stop cock *C* is closed and a fresh supply of rubber is drawn into the cylinder *A* from the supply tank *H*.

The rubber tubing *F* emerges in a sticky condition. To remove the surplus solvent from the tube, a current of warm air is passed through the pipe *J* and escapes through an opening in the plug *K*. The opening is regulated by a stop cock *L* so that the air will flow

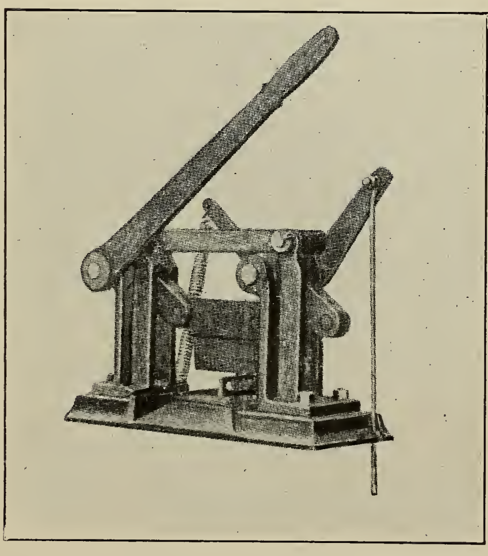


Fig. 194.—The Birmingham Stock Shear.

through the tube at such a rate as to keep it from collapsing. To remove the stickiness of the inside walls, powdered chalk is mixed with the air and blown through.

The Birmingham Stock Shear.

Fig. 194 illustrates a shear for cutting tubing and small mold stock. The cast iron frame is bolted to a bench and has two uprights in which swing two levers pivoted to each end of the shear knife. This is operated either by hand or foot lever. A hard wood strip protects the cutting edge.

The Excelsior Stock Cutter.

The machine shown in Fig. 195 cuts tubes or round stock in short lengths. The two side-frames and table grooved for ten tubes are bolted together and support the feed rollers, cutting knife, and the cam and driving shaft. The machine is bolted to a table and is belt driven. On the drive shaft between the frames is a cam that operates the cut-

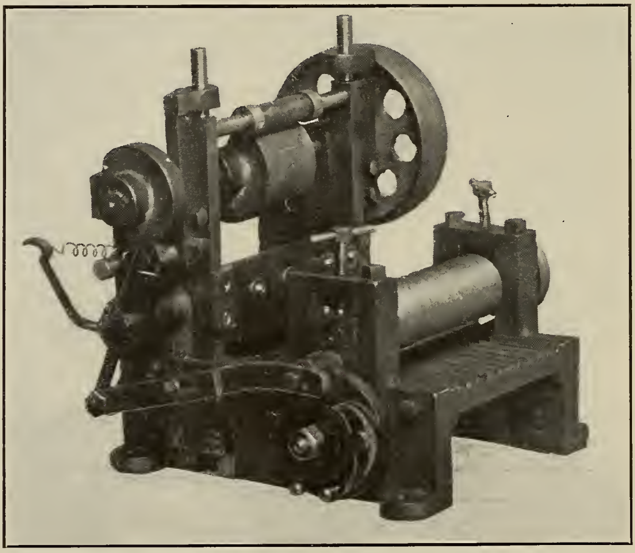


Fig. 195.—The Excelsior Stock Cutter.

ting knife. On the end of the drive shaft is a cam that operates the feed rollers through adjustable levers and a ratchet wheel. The stock is fed forward the required distance by the feed rollers. The cam on the driving shaft operates the reciprocating knife which cuts off the

stock. The operation of the machine is continuous and rapid. It can be adjusted to cut off various lengths of stock.

The Holmes Stock Cutter.

Fig. 196 shows a three-speed power cutter, for cutting stock from a tubing machine into suitable lengths. The rapidly revolving cam-shaped knife severs the stock with a shearing cut. The stock is fed

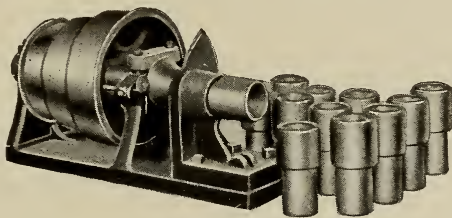


Fig. 196.—The Holmes Stock Cutter.

through a die against a stop which determines the length. Several dies, for various sizes and shapes of stock, are shown in the illustration. The device cuts any size up to 1½ inches in diameter and 2¾ inches long. The capacity is from 9,000 to 15,000 pieces per hour.

CHAPTER XII.

SPREADERS, DOUBLERS AND SURFACE FINISHERS.

SPREADING or knife coating is a process in which a thin coating of rubber in solution is applied to one or both surfaces of a sheet of fabric. The equipment of a complete coating or proofing plant consists of washers, dryers, mixing mills, churns, spreading, doubling and measuring machines. The vulcanizing equipment consists of a dry heat vulcanizer for single and double texture fabrics and a vapor vulcanizing chamber for electric finished single texture surface fabrics. The spreader in general consists of an iron frame, a steam table for expelling the solvents, brackets and take-offs for cloth in the roll, rollers for supporting and guiding the cloth and an adjustable horizontal knife under which the cloth passes. Against this knife the rubber solution is fed, only a thin coating of which passes under it with the fabric.

The Hancock Spreader.

From the time of Hancock there have been scores of different spreaders invented, most of them based upon the general principles outlined above. Hancock's spreader is briefly as follows: Referring

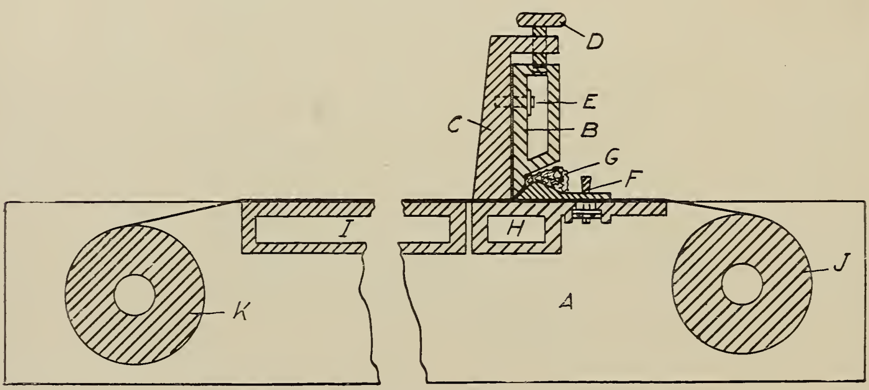


Fig. 197.—The Hancock Spreader.

to Fig. 197, *A* is the frame of the machine, *B* is the spreading knife and *C* is one of the two side brackets which support the knife, *D* is one of two screws for adjusting the knife and *E* the set screw for fas-

tening it in place. *F* is one of the two solution guides, *G* is the rubber dough, *H* is a hollow steam heated plate and *I* is a steam heated drying table. *J* is the fabric supply roller and *K* the take-off roller upon which the coated fabric is wound.

The spreading knife *B* is hollow and heated by steam. Its edge is not sharp but somewhat rounded. It is adjusted vertically by the screws *D* and kept in place by screws *E*. The edge is perfectly straight and accurately in line with the bed plate *H*. That part of the plate *H* which is directly under the knife *B* is raised a little above the level of the bed and is three or four inches wide, flat and smooth. The knife *B* is screwed down to the bed plate *H,* leaving an open space equal to the combined thickness of the fabric and the required film of rubber. The rubber dough is prevented from spreading beyond the width of the cloth by the guides *F*. The fabric to be proofed is rolled up on the feed rollers *J* and the free end passed under the spreading knife and attached to the take-off roller *K*. The knife *B* and the bed plate *H* are maintained at a temperature of 85 to 100 degrees F., while the steam table *I* is kept at 100 to 150 degrees F.

The Standard Spreader.

Spreading machines are used for proofing textile materials with rubber for a great variety of purposes, but mainly for clothing, proof-

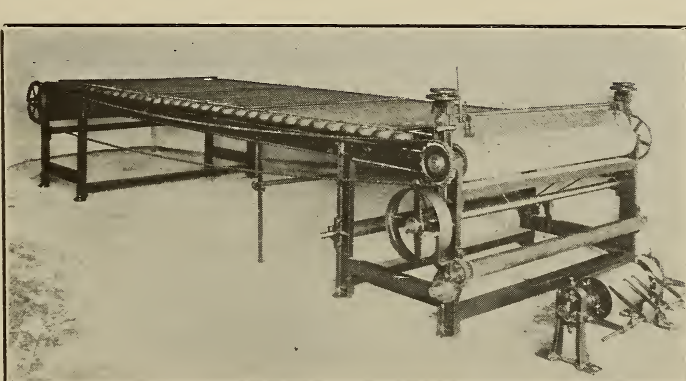


Fig. 198.—The Standard Spreader.

ing, etc. Standard spreading machines are built in widths from 50 to 74 inches and comprise two side-frames of cast iron with cross pieces to hold them rigidly in place. At the front end of the side-frames are openings to receive the journal boxes which support a hol-

low roller with a spur gear on one end. This is driven by a pinion on a counter shaft. This counter shaft, which is journaled in bearings attached to one of the side-frames, has a three-speed cone pulley driven by a belt from an overhead counter shaft. At the front end of the side-frames are bearings to support a square arbor which holds the roll of cloth, also a friction let-off to provide tension on the cloth as it passes through the machine. At a short distance back from the front end of the machine is a wind-up roller similar to the let-off, but driven by belt from the drive roller. At the back end of the machine is a roller driven at the same speed as the drive roller by means of bevel gears, and a long shaft extending from the front to the rear of the machine. A bevel gear on the back of this shaft meshes with a bevel gear keyed to the back roller which drives it whenever the front roller is in motion.

Above the front roller is a steel knife, which is supported in brackets bolted to the side-frames. The lower edge of this knife is adjusted to a rubber covered roller and forms a trough with the surface of the fabric for one side and the knife for the other side. This is adjustable vertically by means of screws and hand wheels in the top of each side bracket. Guides are also attached to keep the solution from running over at the sides. These guides are adjustable and can be set any distance apart. A series of steam plates is attached to the top of the side-frames extending from the front to the rear of the machine, forming one continuous steam heated table from 12 to 24 feet long.

Short length spreading machines—say 15 feet from the rubber-covered roll to the wood drums at the other end of the machine—are not used in the production of single texture surface goods, for the reason that the successive coatings do not thoroughly dry out before the coated surface reaches the wind-up roll. Spreading machines 30 feet in length are preferable. The evaporating surface of the steam heating coil is double that of the short length machine, greater speed in running and greater yardage are also produced. The damage from fire caused by electric operation, which ignites gasoline vapors pocketed underneath the machine, between the rubber-coated roll and the wind-up roll, is also practically eliminated.

Where space is valuable and high steam pressure available, short spreaders are, however, used successfully and the solvent forced out before the fabric reaches the wind-up.

In spreading, the coating material or dough is made of rubber compounded on a mixing mill and then blended with naphtha or other solvent in a cement churn. The operation of the spreader is as follows:

A roll of cloth is placed in the let-off bearings at the front of the machine. Attached to the free end of the cloth is a temporary apron long enough to extend the entire length of the machine and back underneath to the wind-up roll near the front end. When the apron is attached to the wind-up roller, the clutch on the driving shaft is thrown in, and the machine is started. As soon as the temporary apron has passed by the knife the machine is stopped and a batch of dough is placed before the knife and the machine again started.

This coating material rests on the cloth above the rubber covered roller, and the cloth passes under the knife, leaving only a thin film on the fabric. As the cloth passes over the steam table the heat evap-

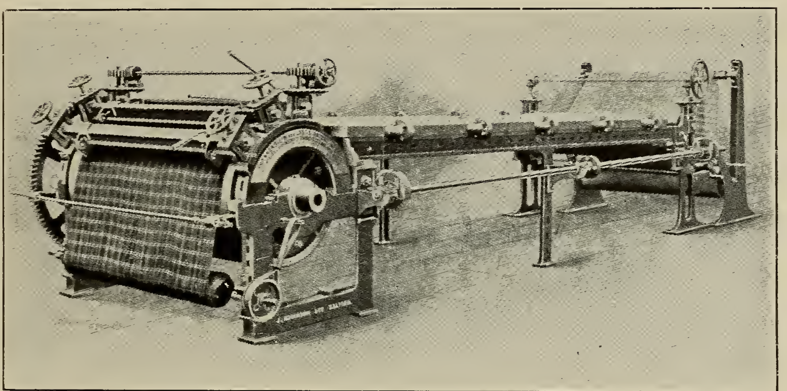


Fig. 199.—The Frankenstein-Lyst Spreader.

orates the naphtha, and the proofed fabric is rolled up on the wind-up roller. If a heavier coating is required the spreading operation is repeated until it is of sufficient thickness. There is no standard for the speed of a spreading machine as it is arranged to suit the stock to be proofed. A low speed of 10 or 15 yards per minute often will give better results than a higher speed. The standard spreader as described above requires about 5 horse power to operate.

In the early days of proofing, fires were of frequent occurrence. A simple device for discharging the frictional electricity consists of copper strips to which are soldered needles that are set just below the guide rollers, but not close enough to tear or mark the fabric. A conductor wire is attached to this device and grounded, usually in water or on a pipe running into the earth. A perforated pipe near the rubber covered roll, through which live steam is forced, is also employed to guard against such fires.

Of special horizontal spreaders there are an infinite variety, the majority being of English origin. The departures from the standard type are in the line of unusual knives, oddly placed drying drums, cooling rolls and automatic solution feeds. There are also types that spread two sheets of fabric side by side; others that have a number of solution knives. There are double, triple and quadruple deckers, all for proofing fabrics with rubber. There are, too, as many more for proofing and varnishing paper and for spreading a great variety of waterproof compound in which no rubber appears. The following, selected from those used for rubber, are typical.

The Frankenstein-Lyst Spreader.

In the Frankenstein-Lyst spreaders, Figs. 199 and 200, there is one spreading roller *A* and four knives. The fabric is first coated lightly in an ordinary spreader and thoroughly dried. This coated

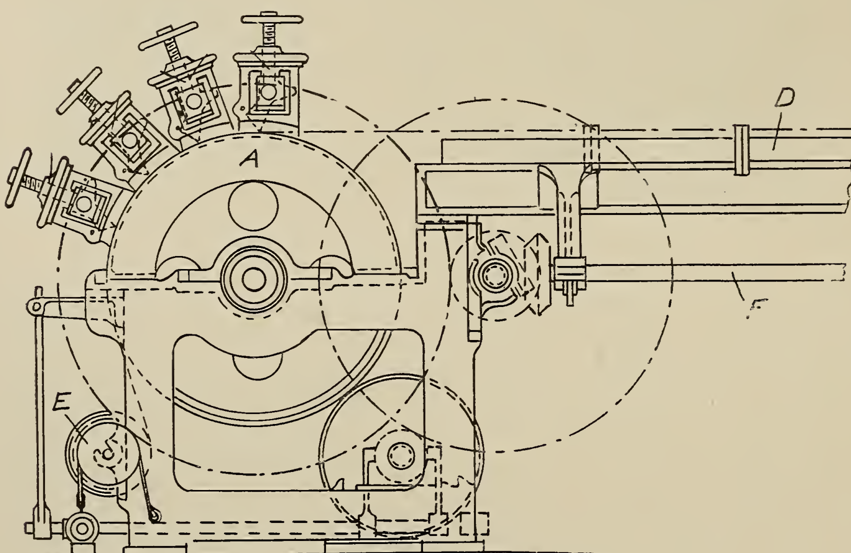


Fig. 200.—The Frankenstein-Lyst Spreader.

fabric then has a thick coating of rubber dough applied to it by the first knife; the others, which are set successively closer to the roller, compress the dough and remove the surplus. The fabric is supplied to the spreading knives from the roller *E*. The shaft *F* drives the

wind-up roller at the opposite end of the machine. After passing over the drying table *D* the material is finished by calendering rolls, placed at the opposite end.

THE ROWLEY-WALMSLEY SPREADER.

The Rowley-Walmsley machine, shown in Fig. 201, is a spreader of the double deck type. There are two spreading knives at each end

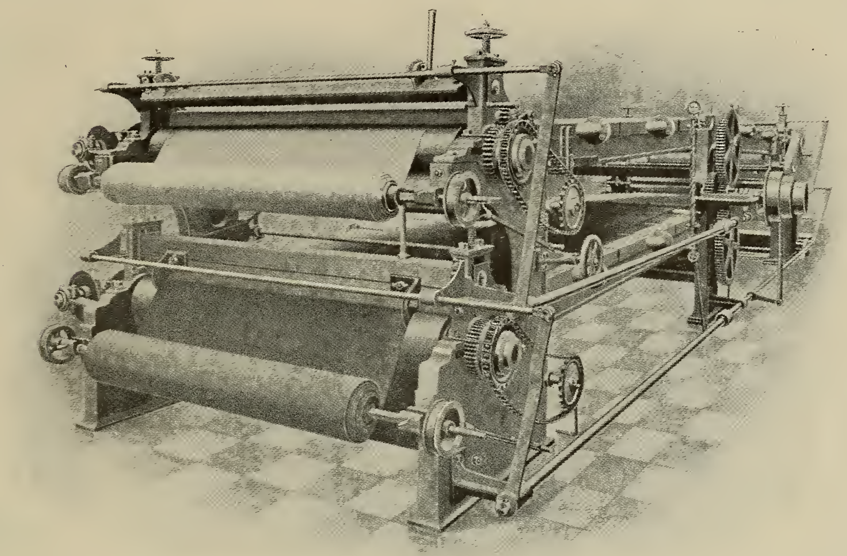


FIG. 201.—THE ROWLEY-WALMSLEY SPREADER.

of the machine, two rolls of fabric being coated simultaneously by one operator. The reversing device is very simple and it is claimed that by thus spreading the dough in alternate directions, liability to porosity is eliminated. Thus, the winding back and handling of the rolls of fabric as in the ordinary machine is avoided. The two drying tables are each 20 feet long, which has been found sufficient to expel the solvent when the cloth is passed at the rate of 8 to 10 yards per minute. The spreader rollers are faced with rubber and are 10 inches in diameter. The machine is 10 feet wide and 27 feet long over all.

THE SALISBURY SPREADER.

The Salisbury machine, shown in Fig. 202, gives the fabric two or more successive coatings of rubber in one operation and dries each coating before the next is applied. In the drawing *A* represents the frame

of the machine that carries the fabric roller *B*, which is provided with a spring controlled brake *C*. The fabric, indicated at *X*, passes from the roller *B* and over a roller *D*. Above this roller is a spreading knife *E* adjusted vertically by the screw *G*.

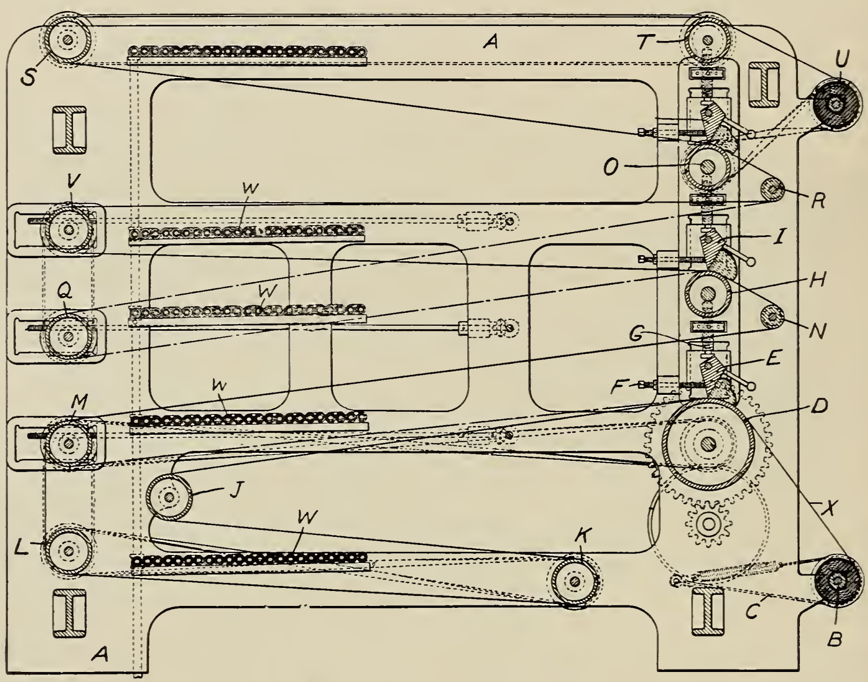


FIG. 202.—THE SALISBURY SPREADER.

Located above this first proofing device is a second one just like it, consisting of the roller *H* and knife *I*. That the fabric, in passing from roller *D* may have sufficient time to dry, it is passed over steam coils *W* by a series of rollers *J*, *K*, *L*, *M* and *N*. A third roller *O* and knife are located above *I* for applying a third coating to the fabric. Since the second coating requires less time to dry than the first, the travel distance between the second and third coating devices is less than between the first and second. Accordingly, the fabric passes over rollers *Q* and *R* and thence over roller *O* to receive a third coat, after which it is led over guide rollers *S* and *T* to the windup roller *U*. Where only two coats of rubber are applied, the fabric is passed from roller *Q* to roller *V*, thence around roller *T* to take-up roller.

The Wood-Robinson Spreader.

Fig. 203 shows the Wood-Robinson spreader. The fabric is proofed from both ends, and dried by two steam heated cylinders placed between the spreading rollers. After leaving the spreading roller, the cloth passes nearly around the cylinder nearest to it, and is conducted by four guide rollers to the second cylinder, passing around it in the same manner and then to the wind-up roller. The time required to reverse and prepare the machine for the return coat is two minutes. Referring

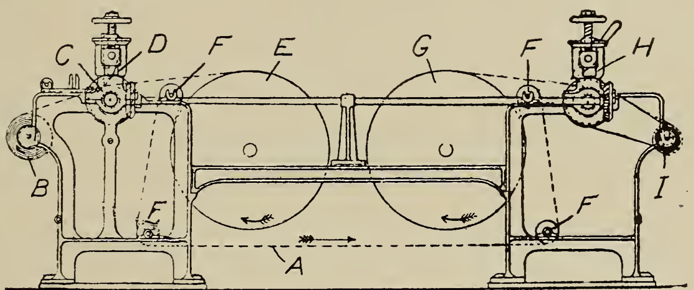


Fig. 203.—The Wood-Robinson Spreader.

to the drawing, the fabric *A* passes from the delivery roller *B* over the spreading roller *C* and under the knife *D*. Then the coated fabric passes almost entirely around the drying cylinder *E*, over guide rollers *F*, and around a second steam heated cylinder *G*. The spreading knife *H* is thrown out of operating position and the proofed fabric is wound up on the roller *I*. If a second coat is to be applied, the knife *H* is thrown in and the knife *D* thrown out, after which the fabric is run back through the machine in the manner already described.

The Coulter Reversible Spreader.

The Coulter machine, shown in Fig. 204, is another type of double-ended spreader. The machine comprises the end frames *A* and *B* carrying spreading knives *C* and *D*, and spreading rollers *E* and *F*. There are also central frames *G* under the steam heated drying table *H*. The fabric *I* passes from the roller *J* over the drum *K* and receives the first coat of rubber solution at *D* and *F*. It then passes over the heating table, the spreading knife *C* and roller *E* being out of operation. It then passes over the drum *L* to the wind-up roller *M*. The drum *K* is, in this case, out of gear and the cloth is drawn through the machine by the roller *M*. The drums *K* and *L* are steam heated and are made of

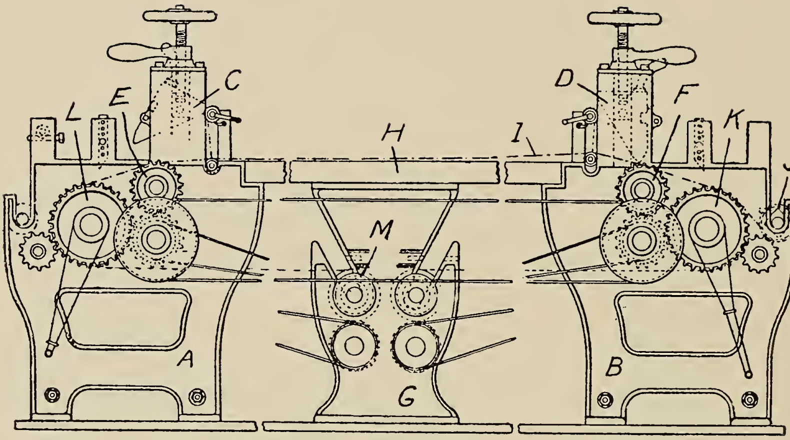


FIG. 204.—THE COULTER REVERSIBLE SPREADER.

sheet metal. The machine is reversed for the second coat, which is applied at the opposite end of the machine.

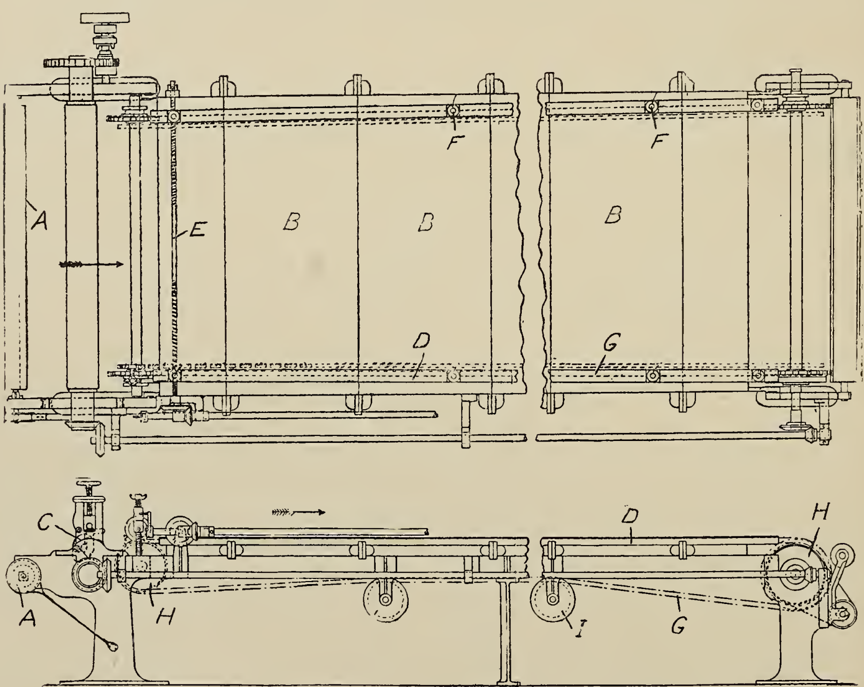


FIG. 205.—THE BIRLEY-MACINTOSH SPREADER AND STRETCHER.

THE BIRLEY-MACINTOSH SPREADER AND STRETCHER.

Woven fabric decreases in width when bleached or dyed, and if it is stretched before proofing it shrinks again during the spreading. The Birley-Macintosh spreader, Fig. 205, stretches the fabric in the direction of its width while on the spreading machine. The cloth to be proofed is unwound from the brake roller *A* and is drawn over the spreader roller and under the gage *C* in the usual manner. It passes in the direction indicated by the arrows, over a series of steam heated plates *B* forming the drying table. Running lengthwise of the machine are two guide rails *D* which are adjusted laterally by cross rods *E* attached to *F F*. The rods have right and left hand screw threads which engage nuts in the guide rails. The edges of the fabric are fastened by clips to the endless chains *G* driven by sprockets *H*. By means of the adjustable guide rails and screw rods the cloth is stretched as it passes over the heated table.

THE MANN SPREADING MACHINE.

The Mann machine, shown in Fig. 206, spreads several coats of rubber on the fabric while it travels in one direction. For example,

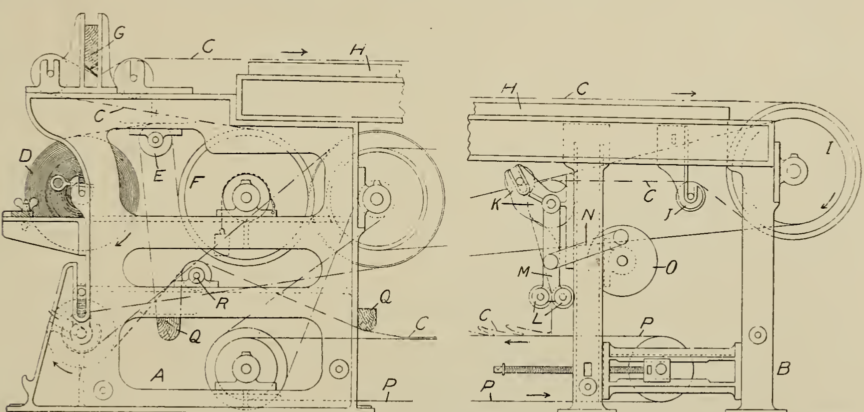


FIG. 206.—THE MANN SPREADING MACHINE.

if it is desired to give six coats of waterproofing material to a piece of fabric, the cloth is passed through the machine, as usual, from a batch roller, and its end is fastened to a leader which is threaded through the machine. But instead of winding up the fabric after receiving its first coat, it is folded on a traveling table by a plaiting-down mechanism until all the fabric is unwound from the batch roller, after which the two ends are joined and the fabric is run through the spreader any

desired number of times. Referring to the drawing, *A* and *B* represent the front and rear ends of the machine. The fabric *C* to be coated is unwound from the roller *D*, passes over an idler roller *E* and around a brake drum *F*. From this it passes over a guide roller and under the knife *G* and then over the steam heated table *H*. Instead of being wound up at the end of the machine, the fabric passes around a drum *I*, over an idler roller *J* and between a pair of rollers *K*. From this point the cloth is run through a folding mechanism, which consists of a pair of rollers *L* on the lower end of a swinging arm *M*. This is rocked back and forth by a connecting rod *N* and the crank *O*, which lays the fabric down in loose folds upon the traveling apron *P*, that moves in the direction of the arrows. When the forward end of the fabric reaches the front of the machine the material is nearly unwound from the roller *D*. This end is brought down from roller *E*, around bar *Q*, roller *R* and bar *Q*. At this point the two ends are joined and the belt of cloth is run through the spreader until the desired number of coatings are applied.

Vertical Spreaders.

The vertical spreader is essentially a French invention and is used more in French practice than in any other. It has, nevertheless, been adopted in both England and Germany, and types of machines that vary somewhat from the French pattern are manufactured in both the countries named. The original vertical spreader was the Decauville. It came into use as a labor saving device. Passing the fabric over through the machine proofed and dried both surfaces. The machine is really both impregnator and spreader. The fabric starting at the bottom, is run through a tank filled with rubber solution, then between squeeze rollers which remove much of the dough on the surface, the remainder being removed by spreader knives. After that the coated fabric passes up and between steam heated plates built vertically at the top and down one side to the wind up. The plates are arranged in frames and can be moved quite close together or drawn some distance apart by a simple mechanical arrangement.

Recent machines have arrangements for carrying away the naphtha fumes and condensing them for re-use.

The Decauville Vertical Spreader.

The Decauville vertical spreading machine is shown in Fig. 207. The fabric starts at the bottom of the machine and both sides are spread at once. It is then passed between the two vertical drying tables *A* and *B* heated by steam pipes *C*. The tables are about 12 feet in height, so

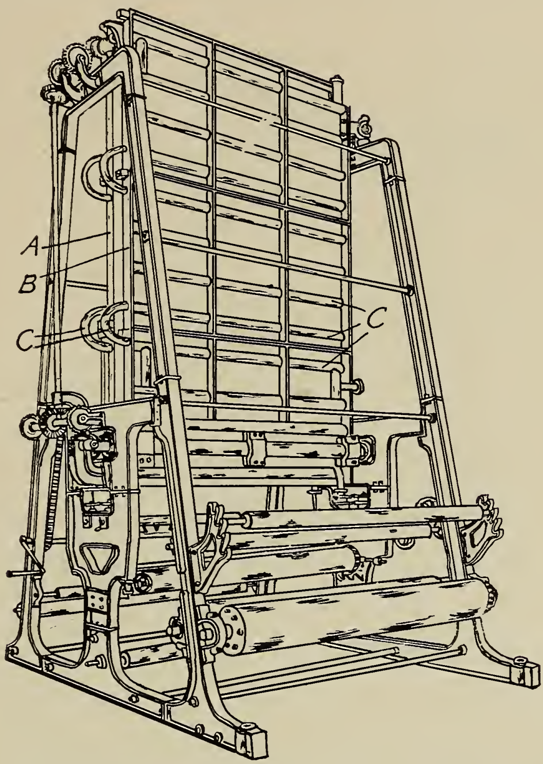


Fig. 207.—The Decauville Vertical Spreader.

that the fabric coming out at the upper end of the machine is perfectly dried. It is generally run twice through the impregnating tank. Such machines are built for any width of fabric from 56 to 96 inches.

German Vertical Spreader.

The vertical spreader shown in Fig. 208 comprises two steam heated tables *A* and *B* with corrugated surfaces, and made sectional, heated by steam pipes *C*. The tables are braced and supported by a cast iron frame. The fabric, after passing from the let-off roller through a tank *D* of rubber solution placed underneath the machine, passes between squeezing rolls which are adjusted by the hand wheel *E*. It then passes to the top of the machine over the surface of the heated table, over guide rollers *F* and *G*, and descends to the opposite side of the machine, where it is wound up on the roller *H*. If the fabric requires a longer time to dry, it can be passed over the inside of the heated plates as well as the outside. The machine is made for coating fabrics up to 79 inches in width.

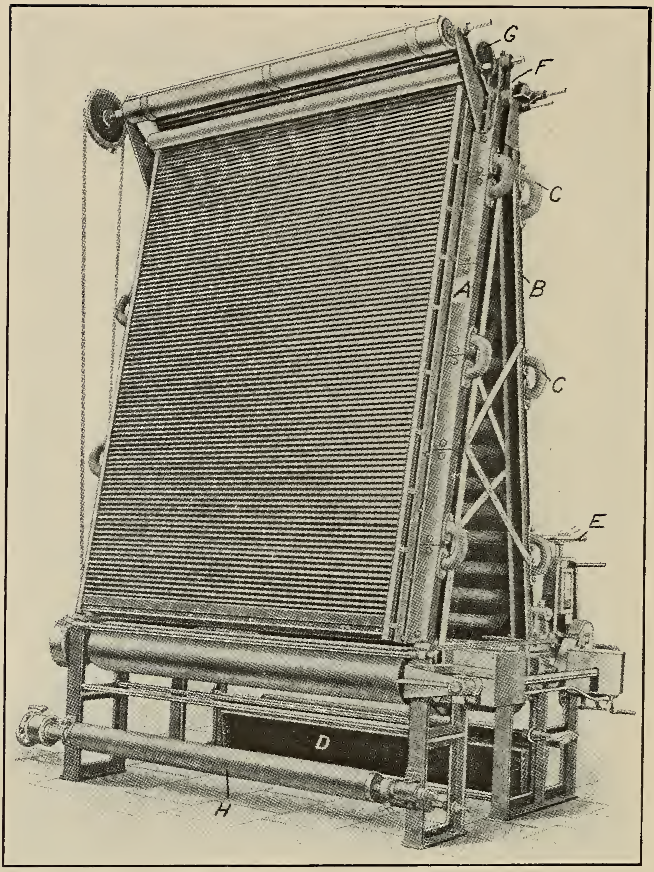


Fig. 208.—German Vertical Spreader.

English Vertical Spreader.

Fig. 209 shows an English vertical spreader, in which the fabric passes from the brake roller *B* around roller *J* and between the spreading roller *C* and knife *D*, thence to the top of the machine around a steam chamber *E* which dries it. It then passes down to the wind-up roller *F*. Motion is imparted to the fabric by chains *G*, which drive a roller at the top of the frame. These chains have hooks which engage the fabric when starting it through the machine. When the cloth has received one coat it is wound up on the roller *F*. The fabric is then passed around roller *J* and spreading roller *C*. The gage *H* is placed in operation, the gage *D* is thrown out and the direction of the machine is reversed. At the same time the brake *K* is shifted to the roller *F*.

For doubling, a supplementary roller *L* is provided on both sides of the machine for the lining cloth. The proofed cloth is wound on the roller *B*. The ends of the two fabrics are brought together around the spreading roller *C* under a pressure roller placed above the roller *C*

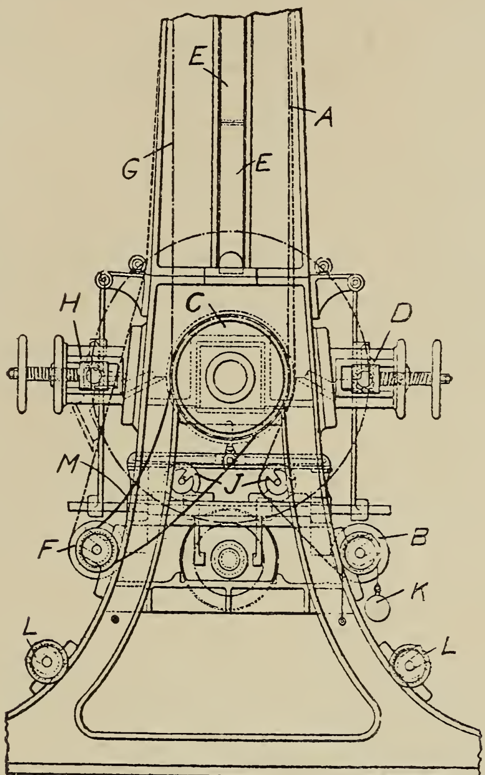


Fig. 209.—English Vertical Spreader.

and down the opposite side to the wind-up roller. The belt *M* is slack so that it will slip, as the speed of the wind-up roller must decrease as the fabric is wound on it.

The Howkin Roller Spreader.

The Howkin spreader differs from the usual type in that the knife is replaced by a roller driven at a different surface speed from that of the main roller and is pressed against the latter by adjustable weights. The drawings, Fig. 210, show a front elevation and an enlarged, part side view of the machine. The spreading roller *A* is placed above the main roller *B* and is pressed down upon it by weighted

levers C which rest on sliding bearings D. The rollers A and B are connected by a belt E and a train of gears F, G and H. The spreading roller A may be raised for cleaning or for passing the fabric between the rollers by hand levers J. In order to prevent the solution from flowing over the sides of the fabric, gages K are provided on each end of the cross bar L. The roller A can be adjusted for different fabrics and thickness of the waterproofing material. The pressure

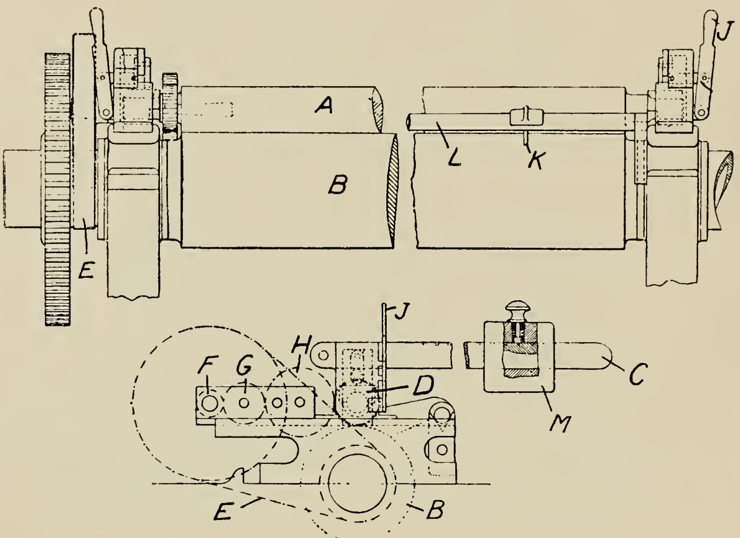


FIG. 210.—THE HOWKIN ROLLER SPREADER.

of roller A upon the fabric may be varied by sliding the weight M back and forth on the lever C.

COATED FABRIC DRYER.

An unusual type of apparatus for drying coated fabrics is shown in Fig. 211. The drawing shows the fabric A coming from the spreader B and passing through the dryer. The latter comprises a long casing divided into compartments C, D and E. In the first and last of these compartments are rotating drums F and G carrying an endless conveyor H. A blast of hot air is supplied to the dryer by a flue I communicating with the compartment E. After passing over the fabric in this compartment, the air is exhausted by a fan J through the flue K into compartment D. It is then exhausted by another fan L through the flue M into compartment C. As the air passes through the suc-

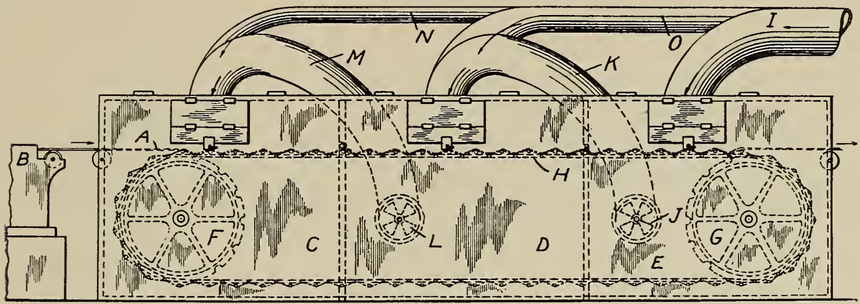


Fig. 211.—Coated Fabric Dryer.

cessive compartments it becomes more or less saturated with moisture when it is finally exhausted into the atmosphere. The flues N and O leading from flue I are provided with dampers to regulate the hot air supply in compartments C and D.

The Bridge Polishing, Curing and Pasting Machine.

The apparatus shown in Fig. 212 is really a combination of three machines in one. It consists of two independent machines A and B placed a short distance apart and a wooden drum C fixed to the ceiling.

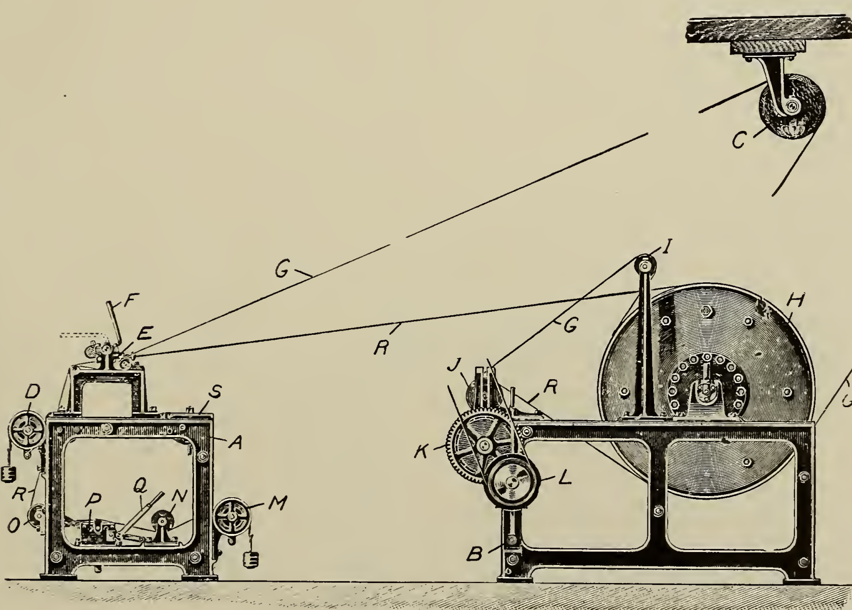


Fig. 212.—The Bridge Polishing, Curing and Pasting Machine.

When the machine is used for polishing cloth, the fabric is wrapped on the brake roller *D*. It then passes under a rubber faced doctor *E*, in front of which the polishing material is placed. The lever *F* which controls this doctor is shown in its raised position, its operating position being indicated by the dotted lines. From the doctor the cloth *G* passes over the drum *C* and down to the steam heated drying cylinder *H*. The fabric passes half-way around this cylinder and then over a guide roller *I*, after which it is wound upon a wooden roller *J*. This roller is driven by frictional contact with the drum *K* which is driven by a spur gear and a pinion on the main shaft. This is driven by belt pulley *L*.

When the machine is used for curing, the proofed cloth on the roller *M* passes under the guide rolls *N* and *O*, over a slate roller in the tank *P*. This roller revolves in the vulcanizing solution which it distributes over the surface of the fabric. On the side of the tank is a lever *Q*, by means of which the fabric may be lifted out of contact with the slate roller. After being treated, the fabric, which is indicated by the line *R*, passes to the top of the frame and across to the heated cylinder *H*. After passing slowly around this cylinder until it is cured, the fabric is wound up in the same manner as described above in the polishing process.

When the machine is used for pasting, the fabric is wound by hand from the roller *M*, over a steam heated pasting tank fixed to the top of the frame at *S*, and then to the roller *D*. When all the cloth is on the front roller it is ready for polishing or curing as described above.

Chalking Machine.

The chalking machine shown in Fig. 213 is used to prevent the cloth from sticking to the rubber stock. The fabric is wound on a roller *B* which is provided with a brake. The top of the frame carries a chalk box *E* in which revolves a brush extending the full width of the machine. This spreads the chalk evenly over the surface. At the other end the fabric is wrapped upon another roller which is driven by the belt *C* through a pair of spur gears. This roller is mounted on the same shaft with the gear *D*. Carrier rollers are fixed to the top of the frame to give the fabric the necessary tension over the chalking roller and the brushing roller *F*. The latter removes the surplus chalk and is usually enclosed in a box.

The Squires Starching and Cleaning Machine.

In Fig. 214 the rear end of a spreading machine is shown, equipped for starching, cleaning by vacuum and brushing single texture

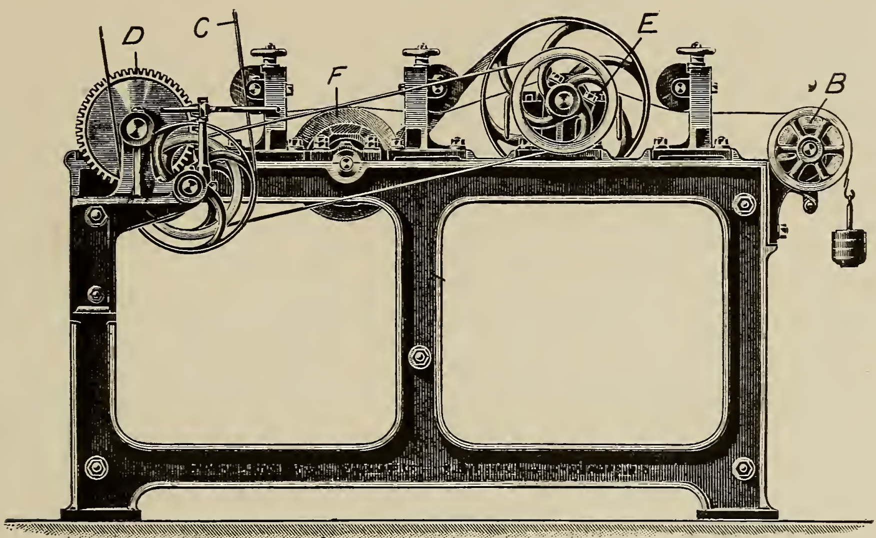


Fig. 213.—Chalking Machine.

goods. The goods are spread at the front end of the machine and pass over a steam heated table and under the starcher *A*. Surplus starch is removed by the motor driven vacuum cleaner *B* and the revolving brush *C* and deposited in the box *D*. The starch is dried and stored in the steam heated dryer *E*.

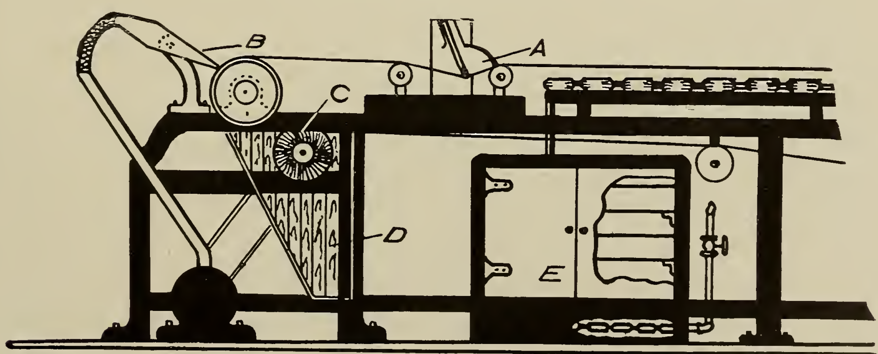


Fig. 214.—The Squires Starching and Cleaning Machine.

The Berry Printing Machine.

In color printing on the rubber surfaces of waterproofed fabrics, it was formerly customary to first apply farina to hold the color. Berry's machine eliminates this necessity by spreading a thin film of water over the rubber before it enters the printing machine. The apparatus comprises four rollers revolving in troughs of water, and a means of keeping the fabric under tension as the water is being applied. Referring to the drawing, Fig. 215, upon the frame *A* are mounted two metal troughs *B* and *C*, in which revolve four copper rollers *D* and *E*, and *F* and *G*. The troughs are fitted with a water inlet pipe *H* and outlet pipe *I* by means of which a constant water level is maintained in the troughs *B* and *C*. The trough *C* is fitted with an overflow pipe *J* connecting with the outlet pipe *I*. The fabric *K* enters the machine in the direction of the arrow and passes over the loose roller *D*. The other

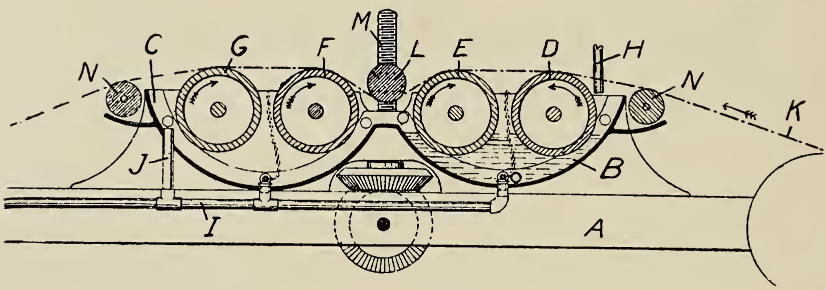


Fig. 215.—The Berry Printing Machine.

three rollers are driven by gearing in the opposite direction from that of the fabric and spread a thin film of water over the rubber surface. Each of the gear-driven rollers has a friction clutch so that it may be thrown in or out of engagement with the driving chain. Between the troughs is placed a transverse bar *L* under which the cloth is passed. When this bar is lowered by the adjusting screws *M* the fabric is brought in contact with the wet rollers. In addition to this bar, small drag rollers *N* are placed at either end of the machine. The frame of this apparatus may be attached directly to the printing machine or at some distance away from it, the fabric being led directly from the troughs to the printing rollers.

The Hodgman Dull-Finish Machine.

The apparatus shown in Fig. 216 is designed for finishing rubber coated fabric with a dull surface as distinguished from glossy and other finishes. Usually, as the rubber coated cloth comes from the

calender rolls, it has a tacky surface and is sprinkled with flour, starch, soapstone or other suitable powder in order that it may be handled. After vulcanization the cloth has to be thoroughly scrubbed in order to remove the surplus powder, after which it must be dried in the air to remove the slight tackiness which still remains. This produces a dull finish. But the object of Hodgman's apparatus is to produce the same finish without requiring the cloth to be scrubbed and sun-dried.

As the rubber cloth comes from the calender rolls *A,* it passes over a guide roller *B* and under a powdering roller *C.* The flour or other powder is placed over the roller *C* and a blade *D* serves to keep it in contact with the fabric. After leaving the

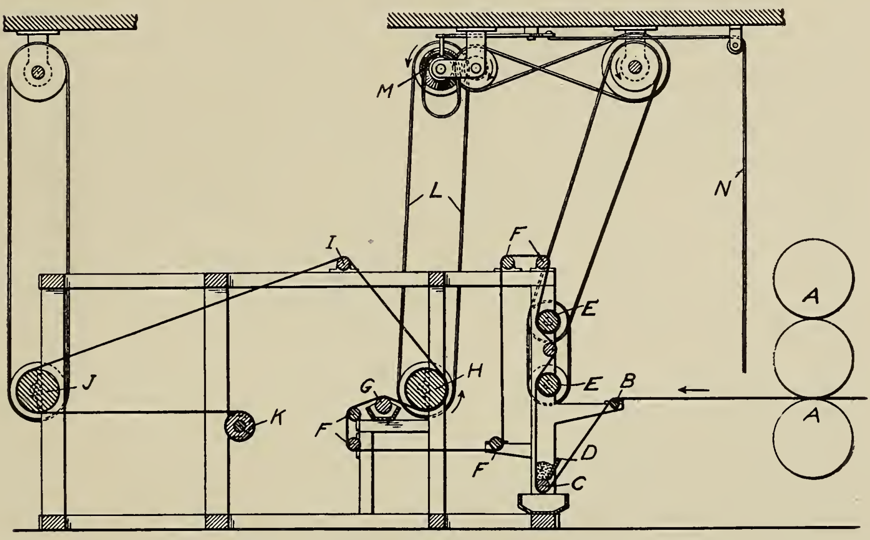


FIG. 216.—THE HODGMAN DULL-FINISH MACHINE.

powdering device, the cloth passes over brushing rollers *E* and a series of guide rollers *F.* Then with the powdered side down, it is passed over a varnishing or inking roller *G* which revolves in a solution of rubber, benzine or naphtha and lamp black. This prepares the surface so the cement used for seams will readily adhere to it. From the varnishing roller the fabric passes over rollers *H, I* and *J,* and then to the wind-up roller *K.* In order to prevent the cloth from moving with a jerky motion and to compensate for the increasing diameter of the wind-up roller a speed-regulating and braking device is employed. From the varnishing roller the fabric passes over the roller *H,* which is covered with emery to provide friction.

This roller is driven by a belt L which is driven from a variable speed device M controlled by the belt shipper N.

The Wood Automatic Solution Guide.

The Wood solution guide, Fig. 217, is designed to compensate for the side creeping of the fabric and is so constructed that the side plates

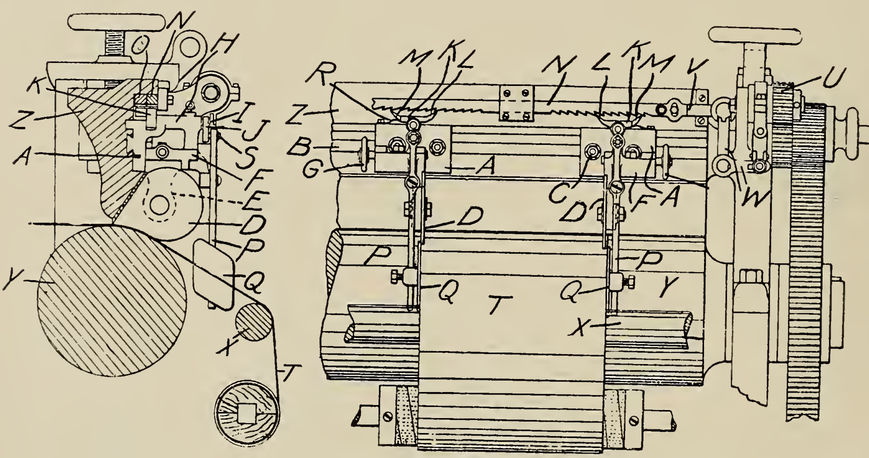


Fig. 217.—The Wood Automatic Solution Guide.

follow the fabric, thus keeping the solution in place. The drawings show respectively, from left to right, a sectional end view and a front elevation of a spreader equipped with the device.

In place of rigid angle brackets there are two sliding or traveling carriages A, which move in slot B. The carriages are made just tight enough by studs C, so that the friction prevents them from moving under the pressure of the proofing solution placed between the solution plates D. Through a tubular part H of each carriage A, passes short rocker shafts I, carrying rocking cranks J on their outer ends and pawls K on the inner ends. Each pawl has two horns L and M, one of which is offset, in order to engage the oppositely toothed ratchet racks N and O. Rods P, pivotally attached to the adjustable bracket A, engage with the cranks J on the rocker shafts I. Plates Q attached to the lower ends of the rods P, lie parallel and close to the edges of the fabric, and are moved by the fabric if the latter gets out of its normal alignment. Flat springs R engage the underside of pawls K and tend to move the crank pins S and top of rods P downward, as regards the fabric T. They also tend to move the plates Q inwardly until they

come in contact with the edge of the fabric. The two oppositely toothed racks *N* and *O* above the pawls *K* are fastened together and slide back and forth in bearings. The racks are vibrated or reciprocated by means of a small gear *U* having an eccentric hub on the inner end, which reciprocates the racks by means of a link *V* and bell crank lever *W*. The fabric passes over the rollers *X* and *Y*, and under the gage *Z*. The sliding carriages *A* are set the proper distance apart and plates *D* adjusted to the fabric.

When the machine is running, the springs *R* keep a suitable pressure under the pawls *K* and the plates *Q* are lightly pressed against the edges of the fabric *T*. If the fabric creeps sidewise and moves away from one of the plates *Q*, the horn *M* on the pawl engages with the vibrating rack *O* on that side of the machine and remains in this position until the sliding carriage *A* has been moved by the rack to bring the plate *Q* again in contact with the edge of the fabric. This brings the solution guides *D*, the rod *P* and pawl *K* in their normal positions, when the carriages will remain stationary until the fabric again changes its alignment. When the fabric moves away from one plate *Q* it presses the plate on the opposite side, engaging horn *L* on that side with the rack *N*, causing the carriage and guides to move outwardly and remain in that position until plates *Q* again make contact with the fabric. Thus the two plates follow the fabric, keeping the solution guides in alignment with it.

CHAPTER XIII.

SPREADERS, DOUBLERS AND SURFACE FINISHERS—(*Continued*).

Doubling Calenders.

FOR many purposes, such as for double texture waterproof clothing, tennis shoes, etc., the cloth is doubled upon a lining; that is, the coated textile material used for the outer side of the article is lined with a thinner fabric. This is done after coating by a doubling calender, which is usually constructed as follows:

There are two side frames held in position by stretcher plates. In these housings are two rolls, one above the other. The lower roll is in fixed bearings while the upper is journaled in bearings that can be raised or lowered by screws and hand wheels at the top of the frame. There is also a spring adjustment of the top roll so that it does not have a positive alignment with the lower roll. On the rear of the housings are bearings for a square arbor with a wind-up mechanism like that used on the spreading machine. On the front of the frames are let-off bearings for two rolls of proofed cloth.

The neck of the lower roll is provided with a spur drive gear which engages a pinion on a counter shaft underneath. On this countershaft is a friction clutch pulley, driven by a belt from an overhead shaft. The top roll is driven from the bottom roll by even spur gears at the opposite end of the rolls. The operation is as follows: The two rolls of coated fabric are placed in the let-off bearings at the front of the doubler. The ends of each roll are drawn between the doubling rolls and attached to the wind-up arbor. The machine is started with the spring pressure of the top roll pressing the two fabrics together against the lower roll. This compresses them into one sheet of material having a rubber coating between the two sheets of cloth.

Vertical Doubling Calender.

In the Bridge doubling machine, shown in Fig. 218, the lower or drive roll *A* is driven by spur gear *B* meshing with a pinion on a shaft, which bears the cone pulley *C* driven by a belt from an overhead shaft. The top roll *D* is driven by spur gears from the drive roll, and is adjusted vertically by screws, on the upper ends of which are worm gears *F* operated by worms on the hand wheel shaft *G*. Attached to each

side of the machine is a set of let-off bearings *H* which hold the two rolls of coated fabric under tension, as the fabric is drawn through the doubling rolls *A* and *D*. A belt-driven wind-up roll *I* is mounted on one side of the frame to wind the doubled fabric into a roll after pass-

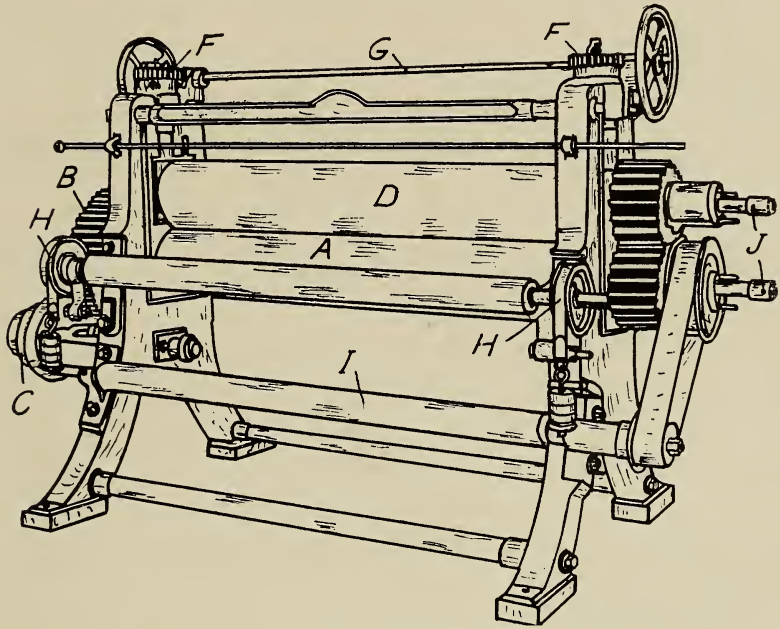


Fig. 218.—Vertical Doubling Calender.

ing through the machine. The doubling rolls are hollow and provided with steam and water connections *J* for heating and cooling, as in the ordinary calender.

Horizontal Doubling Calender.

The doubling calender shown in Fig. 219 differs from the usual type in that the rolls *A* and *B* are placed in horizontal alignment, instead of vertical. The rollers *C* and *D*, which hold the two rolls of proofed fabric, or one roll of fabric and one of rubber, are located on opposite sides of the machine frame *E*. The fabric from roller *C* passes over the roll *A* while that from roller *D* passes over the roll *B*, and meet between the rolls, where they are firmly pressed together. The fabric then passes under an idler roller *F* and is wound up on the take-up roller *G* at the lower end of the frame. This roller is driven by friction from roller *H*, driven by belt pulleys *I* and *J*. This machine is geared and driven very much like the ordinary calender, and the

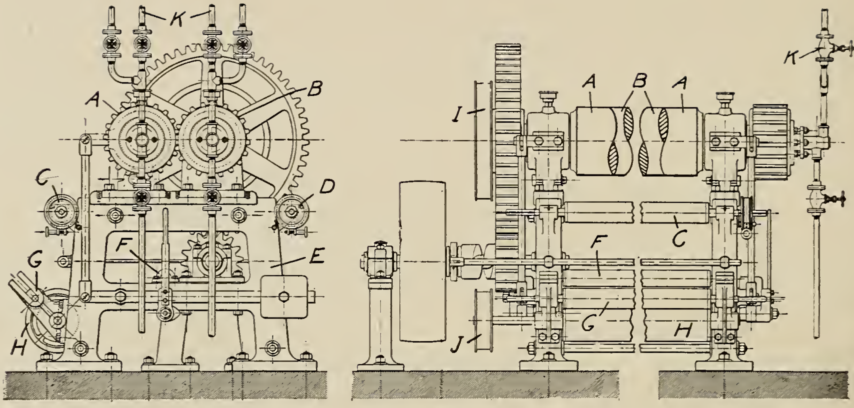


FIG. 219.—HORIZONTAL DOUBLING CALENDER.

doubling rolls are provided with heating and cooling connections *K* in the usual manner.

THE BIRNBAUM DOUBLER.

The drawing, Fig. 220, shows a side view of the principal parts of the machine. The cloth first receives a coating of rubber on the spreader and is then transferred to the doubling machine and wound up on the roller *A*. It then passes over a roller which revolves in a tank *B* containing naphtha or other rubber solvent. This renders the

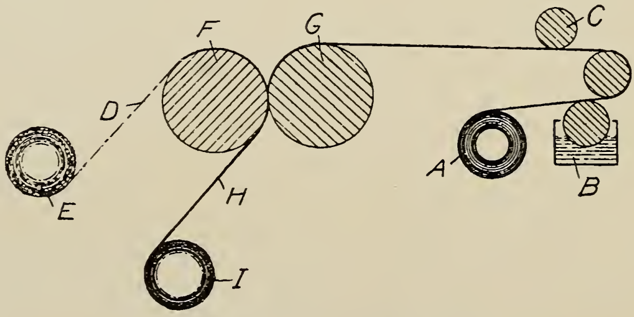


FIG. 220.—THE BIRNBAUM DOUBLER.

surface of the rubber soft and adhesive. Any excess of moisture is removed by a roller *C* or a doctor placed across the machine and covered with suitable absorbent fabric. The rubber surface of the cloth is then brought into contact with an uncoated lining *D* which is unwound from the roller *E*. These two fabrics are pressed together

between the doubling rollers *F* and *G*, and the completed double texture fabric *H* is then wound up on the roller *I*. It is important that no excess of moisture be present on the surface of the softened rubber which, if rendered too sticky, would be forced through the fabric lining and thus spoil the appearance of the finished product.

Fabric Striping.

There are many factories that proof cloth, cure and sell it in the roll to small concerns who do the making up. Such concerns have large plants and often devote themselves entirely to proofing for the trade. Proofed cloth is cured either in a dry heat vulcanizer or it is cold cured. The latter cure allows of many artistic effects in single texture goods that are not possible with the hot cure. A thin coating of transparent rubber over a figured fabric allows the pattern to show through, the colors being slightly toned down; that is, if the rubber be cold cured. Beautiful effects are also produced by dusting the surface with potato starch before applying the vulcanizing solution. This converts the starch into a translucent, silky film. By grooving the solution roller, stripes are formed upon such a surface. Two rollers grooved in spirals, whose grooves do not correspond, produce beautiful hazy lines. Ornamentation is also effected by spreading stripes of colored rubber upon the plain spread surface. The ornamentation, as a rule, is confined to lines.

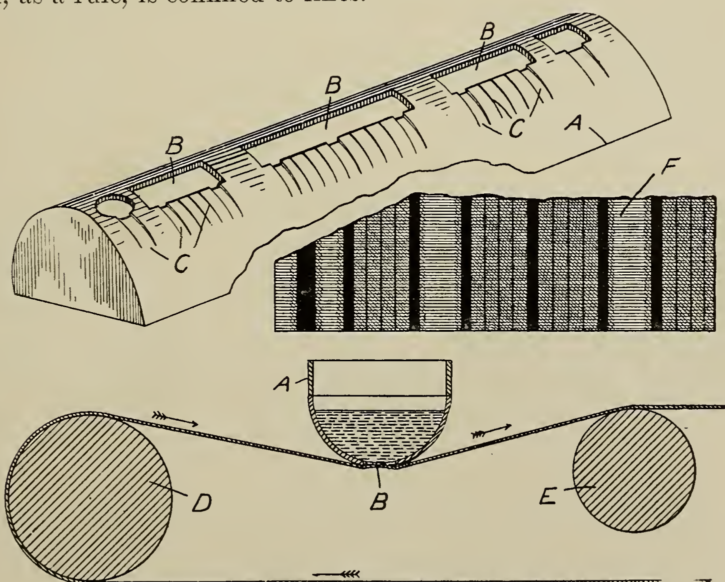


Fig. 221.—The Videto Striping Device.

The Videto Striping Device.

The striping apparatus shown in Fig. 221 consists of a semi-cylindrical trough *A* having a series of slots *B* cut through the lower side. Extending laterally from these slots are a number of shallow channels *C* of different widths. The fabric is led over a roller *D*, underneath the trough which contains the coating solution and over another roller *E*. As the fabric passes under the trough the rubber solution comes into contact with it and a thin film is deposited upon the fabric in stripes of a breadth equal to the full length of each slot *B*, the color of these broad stripes being a compromise between that of the fabric and of the rubber. A thicker film of rubber solution is left upon that part of the fabric which passes underneath the transverse channels *C* and a different color is therefore effected at this part, forming a striped effect as indicated in the diagram of the fabric *F*.

The Guthrie Striping Device.

In the machine shown in Fig. 222, the fabric *A* is placed on the rollers *B* and *C*, which are supported on the ends of the frame *D*.

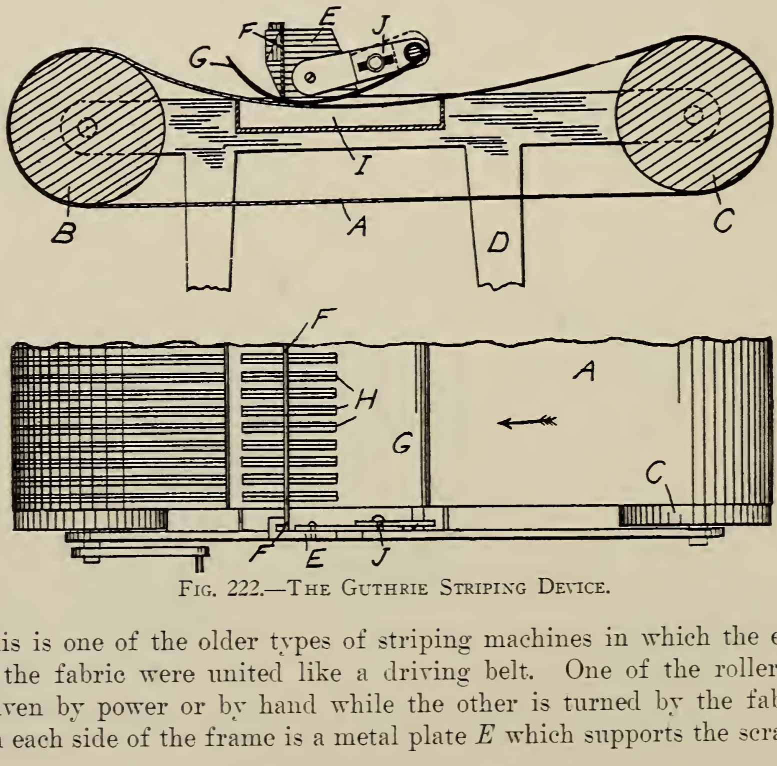


Fig. 222.—The Guthrie Striping Device.

This is one of the older types of striping machines in which the ends of the fabric were united like a driving belt. One of the rollers is driven by power or by hand while the other is turned by the fabric. On each side of the frame is a metal plate *E* which supports the scraper

F. This scraper is held vertically above the curved slotted plate *G*. The lever *J*, which is slotted in the center so that its length and position may be adjusted, has one end pivoted to the metal plate *E* and the other to the slotted plate *G*. The slots in the plate *G* are shown at *H* in the plan view of the machine. The fabric moves in the direction indicated by the arrow and the scraper *F* bears against the slotted portion of the plate *G*, preventing any of the coating material from going past it, except that which passes through the slots to the fabric. Therefore since all of the material entering the slots is spread on the fabric in the form of stripes, the thicker the plate *G* is made, the deeper the slots will be and a corresponding amount of rubber will be spread on the fabric. The solution to form the stripes is placed on the plate *G* back of the scraper and the surplus falls into the trough *I*, from which it may be removed and used again.

The Landin Fabric Feed.

Fig. 223 shows an ordinary spreader equipped with a device for feeding the fabric. This consists of an apron having hooks at one

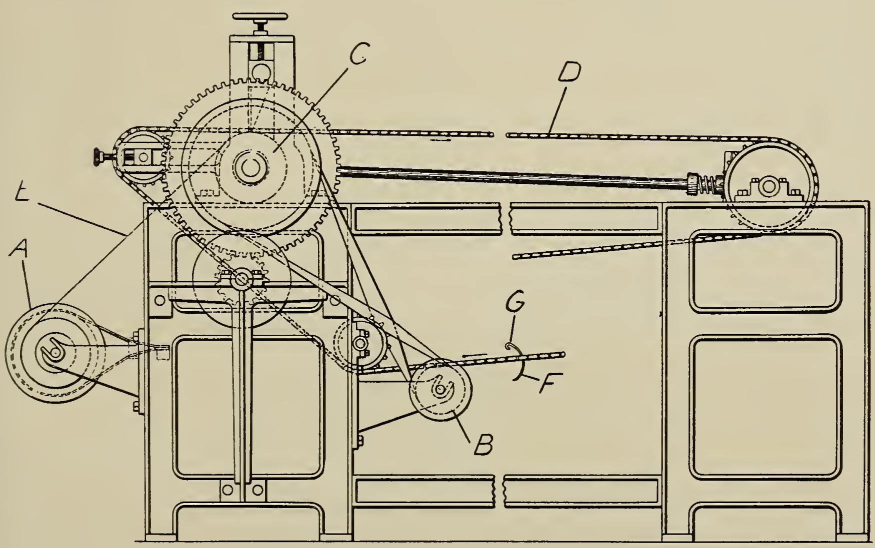


Fig. 223.—The Landin Fabric Feed.

end and a clamping plate at the other, and is run by a pair of sprocket chains, into which the hooks catch.

In the drawing, *A* is the let-off, *B* the wind-up, and *C* the spreading roll, driven in the usual manner. On each side of the spreader

is a sprocket chain *D* for engaging the apron to convey it through the machine to the wind-up. The apron is built up in the form of a pad, having two outer layers of canvas and a middle layer of felt. It is as wide as the fabric *E* and long enough to lap once or twice around the wind-up, forming a smooth cushion for the coated fabric.

On the rear end of the apron is a narrow metal clamping plate to which the fabric may be quickly and smoothly attached. On its forward end is another metal plate *F*, curved to fit the wind-up roll. On each end of this plate is a hook for attaching the apron to the chains *D*, and in the center is another hook *G* which catches on one of a series of rods in the center of the roll *B* when the apron reaches this point.

The operation is as follows: The forward end of the apron is hooked to the chains and the rear end is clamped to the fabric. The spreading knife is raised and the machine set in motion. When the rear end of the apron has passed the roll *C* the knife is lowered and spreading begins. When the plate *F* reaches the wind-up it is automatically disengaged from the chains; the hook *G* catches one of the rods in the center of the roll *B*; the apron and fabric are then wound up in the usual manner.

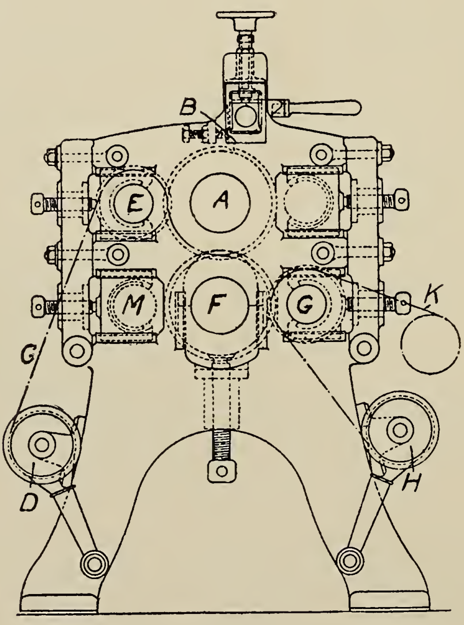


Fig. 224.—The Coulter Roll Spreader.

The Coulter Roll Spreader.

In this calender spreader a thick rubber dough is spread on a roll by a knife and the sheet thus formed is removed by an apron or sheet of adhesive-coated fabric. (See Fig. 224.) The rubber is introduced at the top and is spread over the roll *A* by the adjustable knife *B*. A sheet of fabric *C* from the roll *D* passes over the roll *E* and between *A* and *E*, where it picks up the rubber. The sheet then passes between rolls *A*, *F* and *G* and is wound up on the roll *H*. If desired, a second sheet of fabric *K* may be applied to the rubber as it passes the nip of the rolls *F* and *G*.

Vulcanizers for Coated Fabrics.

In 1882 H. W. Burr invented an interesting apparatus for vulcanizing coated fabrics, especially of the Gossamer type, by exposure to strong electric lights. In this apparatus the curing is preferably effected during the coating process. Referring to Fig. 225 the fabric

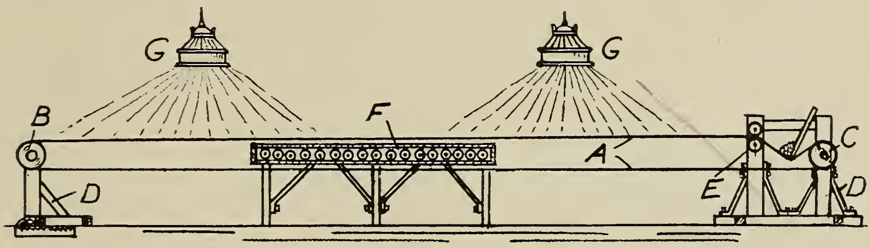


Fig. 225.—The Burr Electric Light Vulcanizer.

A is supported on adjustable rollers *B* and *C* in the frames *D*. The fabric is passed through a spreader or between the rolls of a calender *E*, from which it passes over the steam heated drying table *F*. Above this table are suspended electric lights *G*. The rays are reflected on the fabric as it passes over the table. When the fabric moves horizontally, as is the case in the apparatus shown, transparent glass guards prevent incandescent particles from falling on it. In some cases the lights are arranged one above the other and the fabric is moved vertically up and down on both sides of the lights. As a rule, the best results are obtained by applying successive coatings of rubber, with the light acting continuously.

The Waddington Vulcanizer.

Fig. 226 illustrates an apparatus for vulcanizing waterproofed fabrics in continuous lengths. The fabric *A* is cured by passing through a heated chamber *B*. At the top and bottom of this chamber

are numerous rollers *C*, which may be heated or cooled as required. The inlet *D* and the outlet *E* are made in the form of narrow slits to avoid the loss of heat. The fabric is supplied from the stock roller *F* and passes into the chamber at *D*. It then passes up and down over the many rollers until it finally emerges at *E* and is wound up at *G*. It is found desirable, when single texture fabrics are being treated, to cool one or more of the rollers *C* nearest the outlet by cold water in order to give a better finish. It is also desirable to apply the heat to the fabric by successive stages as it passes through the chamber. This is accomplished by dividing the chamber into separate compartments by transverse partitions. In these compartments the heat may be controlled as required or one or more of the rollers nearest the entrance

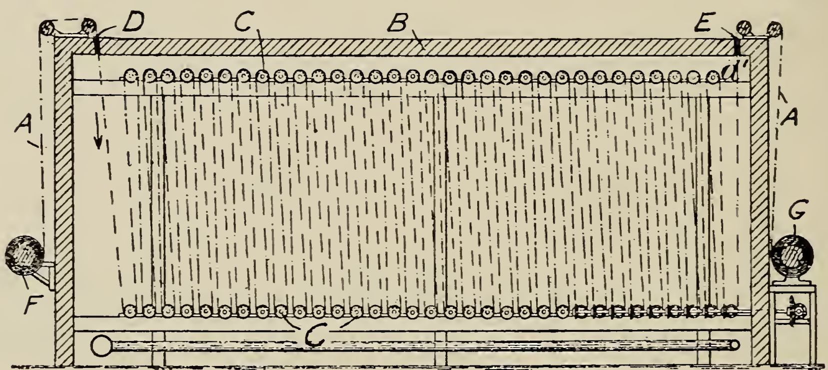


Fig. 226.—The Waddington Vulcanizer.

may be kept cool so that the fabric is prevented from becoming heated too soon to the same degree as the interior of the heating space.

The Vapor Cure.

The vulcanizing of goods by acid fumes, a process often used, is done in a vaporizing room made of clear kiln-dried white wood boards, the ordinary size being 7 feet wide, 7 feet high and 12 feet deep. This room is made with the frame on the outside, the sheathing being on the inside. It is put together with galvanized nails, screws and hinges, the steam fittings also being galvanized. This is lined with ¼-inch asbestos board and has about 180 feet of 1-inch pipe placed inside of the room about six inches above the floor for heating. The pipe is arranged in two coils, one on each side of the room, leaving a clear space in the middle. Strips of wood 1¼ inch wide, ⅞ inch thick and 7 feet long, with round corners, are placed crosswise in the room 2 inches apart and 6 inches below the ceiling. All the

uncovered woodwork is coated with shellac. There are four small sliding doors, one on each side, the bottom being level with the steam pipes. A ventilator with a damper is placed at the rear of the room and as near the top as possible. The front of the room has folding doors the entire width of the room. The coated cloth is festooned from the cross bars, the bottom folds hanging about twelve inches from the floor. A room of this size will hold about 400 yards of fabric. A small china dish is placed on the pipes at each of the sliding doors, and in each one is poured one-eighth of an ounce of chloride ot sulphur. The doors are closed and the room kept tight for from 15 to 20 minutes, depending upon the thickness of the goods. The ventilator and the small doors are then opened, and about 20 minutes allowed for the fumes to pass off. In the meantime clean plates are placed on the pipes, each plate containing an ounce of ammonia. After 20 to 30 minutes with the ventilator opened about half the time, the goods may be removed.

The Bridge Cold Cure Machine.

The machine shown in Fig. 227 is used for cold curing, starching and finishing. The fabric to be treated is wound on the brake roller *A*, from which it is conducted under the guide roller *B* and over a slate distributing roller revolving in the tank *C* containing the vulcanizing liquid. By means of the lever *D* the fabric may be raised

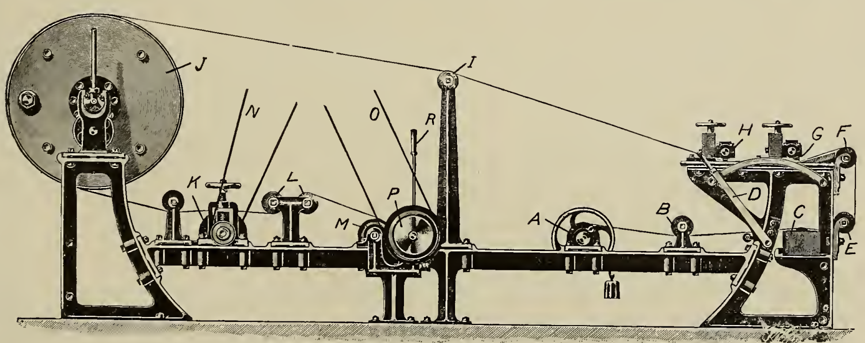


Fig. 227.—The Bridge Cold Cure Machine.

out of contact with the distributing roller. After being treated the fabric passes around guide rollers *E* and *F*, down an incline and under the steel bladed doctor *G* which spreads the farina or starch evenly over the surface of the cloth. It then passes under a second gage *H* with a smooth wooden edge, and thence over the roller *I* to the steam drying cylinder *J*. After being cured the fabric passes over a high

speed brush *K* and then between two wooden guide rollers *L* to the wind-up roller *M*. The brush and wind-up roller are driven respectively by belts *N* and *O* from an overhead shaft. The shaft of the cone pulley *P*, which drives the wind-up roller, has a clutch operated by the lever *R*. When the machine is used for curing only, the fabric does not pass under the two gages *G* and *H* nor does it come in contact with the brush, but passes directly from the drying cylinder to the wind-up roller.

The Kremer Impregnator.

The machine shown in Fig. 228 is for saturating fabrics by passing them through rubber solution and afterwards squeezing the fabric

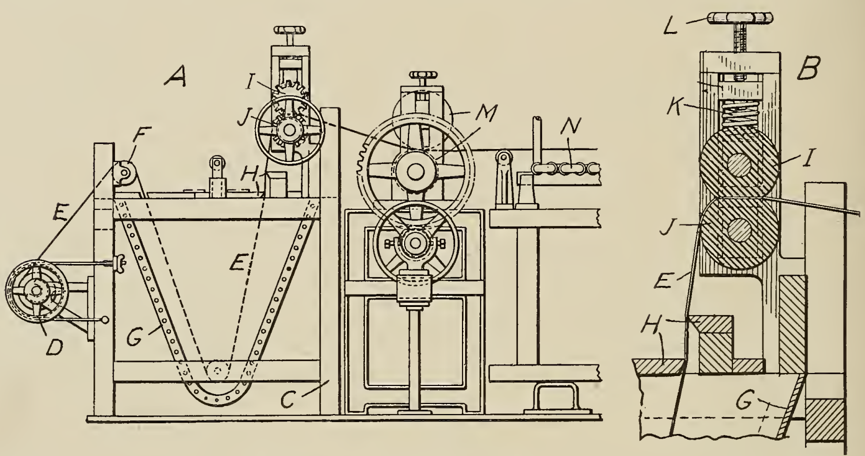


Fig. 228.—The Kremer Impregnator.

between two rubber rollers. Referring to the two drawings, *A* represents one end of the machine while *B* is an enlarged sectional view showing the scrapers and rubber rollers. On the front of the frame *C* is stock roller *D* from which fabric *E* is unwound. The fabric passes up over roller *F* and down into tank *G* containing the rubber solution. While passing through this tank the cloth becomes saturated and the surplus is scraped off by the scrapers *H*, and falls back into the tank. The fabric then passes between two rubber rollers *I* and *J* held together by spring *K* and adjusted by screw *L*. When these rollers are compressed, as shown in drawing *B*, their line of contact becomes a surface of considerable area and during the passage of the fabric between these rollers the rubber solution is pressed into the fibers. From rollers *I* and *J* the fabric passes between a second pair of rollers *M* and over a steam heated drying table *N*, only a short

section of which is shown. From this drying table the fabric is wound up at the opposite end of the machine.

The Siverson Impregnator.

The impregnator, shown in Fig. 229, is designed especially for impregnating heavy fabrics. The apparatus comprises an inner impregnating tank *A*, adapted to receive the plastic mass of unvulcanized rubber compound and the fabric. Outside the tank *A* is a jacket *B* forming an air space *C*. Outside of this jacket is a shell *D* forming the

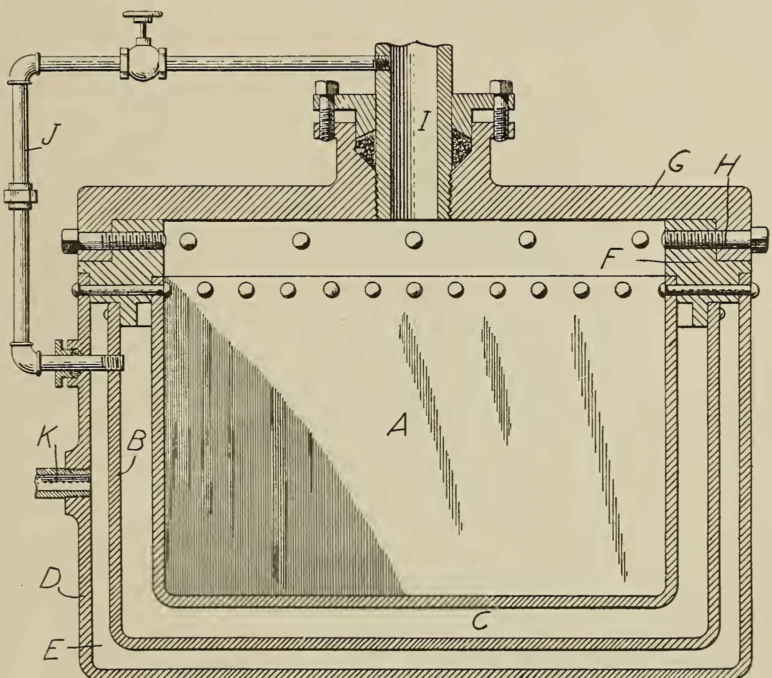


Fig. 229.—The Siverson Impregnator.

space *E*, heated by steam. The two spaces *C* and *E* are closed by the metal ring *F*, and a cover *G* is provided for the tank *A*. After the fabric and rubber have been placed in the tank the cover is secured by means of bolts *H* and air pressure is applied through pipe *I* for forcing the rubber solution into the fabric. A branch pipe *J* conducts a portion of the compressed air to the space *C*. This provides a heat-insulating medium which prevents the rubber from vulcanizing before the fabric is thoroughly impregnated. This process enables a much denser mass of rubber to be used than where no insulating medium

is placed between the steam jacket and the tank. Heat is supplied to the space *E* through the pipe *K*. A pressure of 75 pounds is employed in the tank *A* and a pressure of 45 pounds in the insulating space. The temperature of the steam jacket is maintained at about 350 degrees F.

The Destribats Impregnator.

Among the newer machines for use in connection with the proofing of fabrics is one invented by Destribats. The object is to remove the air from the fabric and coat it with rubber before coming in

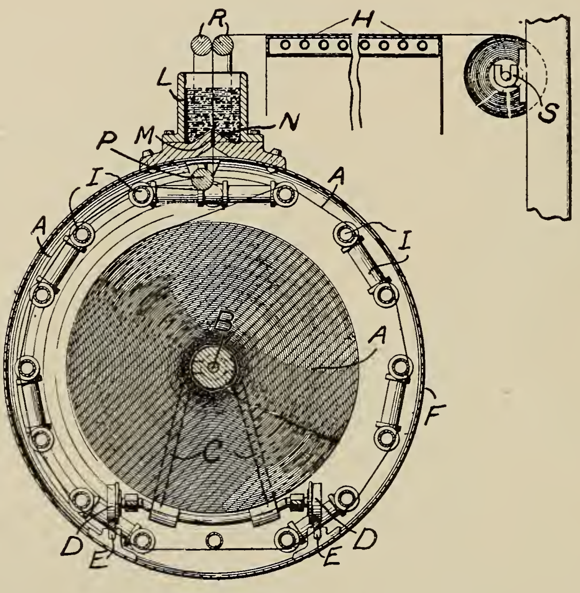


Fig. 230.—The Destribats Impregnator.

contact with the atmosphere. The fabric is also heated by steam at the same time the air is exhausted so that it is perfectly dry.

Referring to Fig. 230, which shows a cross section looking toward the end of the machine, the roll of fabric *A* is mounted on the shaft *B* in the frame *C*. This has rollers *D*, which run on the track *E* in the shell *F*, which has a removable door. The air is exhausted from the shell by means of an ordinary vacuum pump. Surrounding the roll of fabric are steam pipes *I*, and on top of the shell is trough *L* with a long slot *M* and a pair of flaps *N*, to prevent the rubber solution from being drawn into the shell when the air is exhausted. A

roll of fabric which is to be impregnated is placed in the frame *C* and run into the cylinder. The end is carried around the steam pipes *I* and under the roller *P,* and then vertically through the slot *M* into the rubber solution. The air is exhausted from the cylinder and the cloth is impregnated. The coated fabric then passes between a pair of rollers *R* and over a heater *H,* after which it is wound up on the roller *S.*

The Rushworth Shower Proofer.

The machine shown in Fig. 231 is designed for waterproofing textile fabrics with parafine wax compositions made up in the form of slabs which melt at a temperature below that which would damage

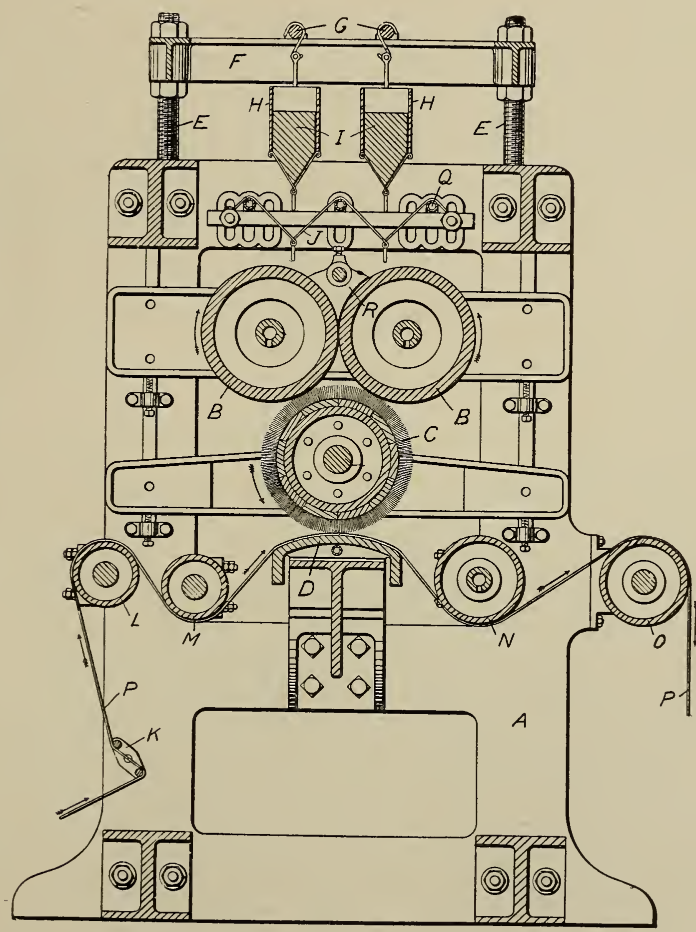


Fig. 231.—The Rushworth Shower Proofer.

the fabric. The drawing shows a transverse section of the machine. The frame *A* bears two steam heated rollers *B* running the full width of the machine. Below these rollers is a cylindrical brush *C* and below this brush is a hollow convex metal plate *D* over which the fabric travels. At the upper part of the frame are vertical pillars *E* carrying a rectangular frame *F* and cross bars *G*. From these bars are suspended two box-like casings *H* with tapered bases of woven wire. These cases contain the slabs of waterproofing compound *I*. Below the wire network is another series of wires *J* above the surfaces of the rollers *B*.

The machine has a tension device *K*, guide rollers *L* and *M* and drawing rollers *N* and *O*. The cylinders *B*, brush *C* and drawing rollers *N* and *O* are driven by gearing in the direction indicated by the arrows, and the surface speed of the brush is faster than that of the fabric. The fabric *P* is mordanted in the usual manner and then passes over the guide rollers and between the plate *D* and the brush *C*. The hollow plate *D* and the two rollers *B* and the roller *N* are steam heated. Heat from steam pipes *Q* slowly melt the waterproofing material which drops from the pending wires on the heated cylinders *B* which transfer it to the brush C. This brush spreads it evenly over the surface of the cloth. End plates *R* confine the material to the cylinders *B* and after the fabric has been passed through the machine the steam is turned off and cold water is passed through the pipes to cool the machine.

The Falter Shower Proofer.

The machine shown in Fig. 232 is designed for the purpose of coating both sides of the fabric in one operation with waterproofing material. The material in the form of solid bars has a wax-like consistency and is applied to the fabric by friction which melts the wax just fast enough to allow an even coat to be spread. Between the frames *A* and *B* is a roller *C* which is mounted diagonally so that the fabric *D* enters the machine at a right angle. The fabric passes from this diagonal roller over an idler roller *E* and then between the roller *F* and the upper edge of the bar *G* of waterproofing material. The fabric then passes around rollers *H* and *I* in the frame *A* and under the idler roller *J* and between the roller *K* and the lower edge of the bar *G* thus coating both sides of the fabric in one operation. From the roller *K* the fabric passes between a pair of heated calender rollers *L* and *M*. The spreading rollers *F* and *K* move toward each other as the bar of waterproofing material wears away, as they are

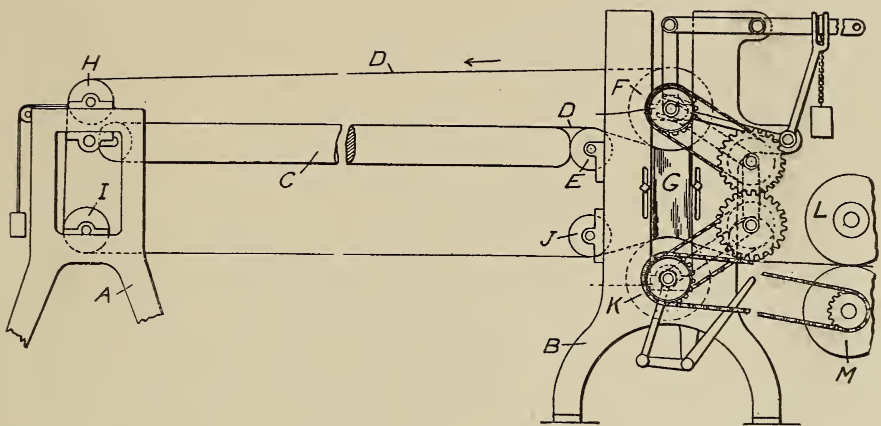


FIG. 232.—THE FALTER SHOWER PROOFER.

mounted in movable bearing blocks which are adjusted by a system of levers and weights. These are so arranged that the pressure of the rollers against the fabric always remains the same, resulting in spreading a uniform coat of material on the cloth.

SOLVENT RECOVERY.

The recovery of the solvent, which is by no means unimportant, is accomplished in most of the large spreading plants. Of the processes used the following are the most interesting:

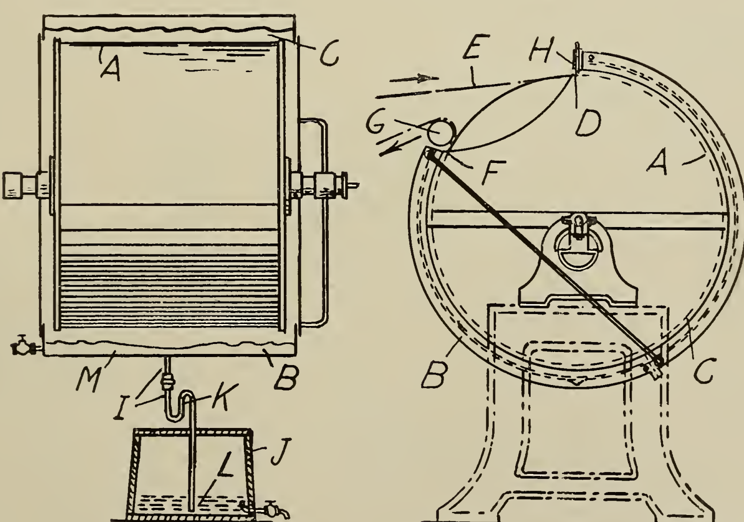


FIG. 233.—THE WEBER-FRANKENBURG RECOVERY APPARATUS.

THE WEBER-FRANKENBURG RECOVERY APPARATUS.

Fig. 233 illustrates a vertical section and a side view in which *A* is a steam heated drum surrounded by a cylinder *B*, with a space *C* between the two parts. In the outer cylinder is an opening *D* to admit the fabric *E*, and an opening *F* through which it passes out over a guide roller *G*. The outer cylinder *B* serves as a condenser and it may be cooled by the atmosphere or by a water jacket *M* surrounding it. A shutter *H* is placed at the entrance *D* to prevent a current of air being carried through. The fabric passes around the steam heated drum *A* and the vapors are condensed upon the cold walls of the cylinder *B*, and flow down the sides of the cylinder, accumulating at the bottom. At its lowest point the cylinder is provided with a drain pipe *I*, through which the liquid solvent is conducted to a tank *J*. In order to minimize fire risks the drain pipe is provided with a siphon bend *K* and the pipe terminates in a water seal *L* at the bottom of the tank *J*. The solvent, being lighter than water, rises to the top and may be drained off as desired.

THE VINCENT APPARATUS.

In the apparatus, illustrated in Fig. 234, the proofed fabric is

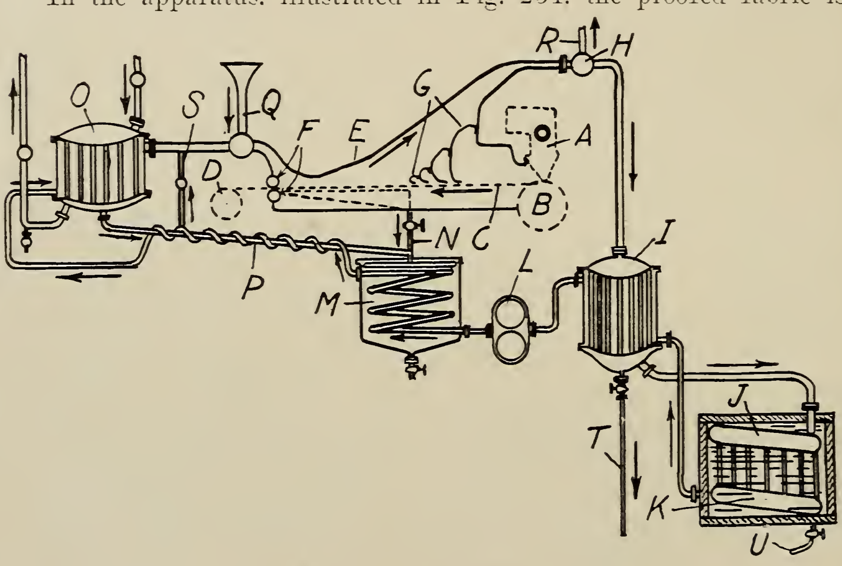


FIG. 234.—THE VINCENT APPARATUS.

continuously unrolled under a closed hood in which the volatile products are vaporized and carried off by a current of heated air. In

the drawing *A* represents the knife of the spreading machine and *B* the spreading roller. The fabric passes over the drying table *C* and is wound up on the roller *D*. The drying table is covered with a large hood *E* to prevent the escape of vapor. To insure this, one end of the hood terminates against the knife *A* and the other against the roller *B*. The joints are kept tight by means of a packing of felt or other substance. The two rollers *F*, between which the fabric passes to the take-up roller, are also sealed by felt packing. Inside the hood are a number of curved plates *G* intended to obstruct the air current in case the joints were not tight. The solvent vapors leave the hood at *H* and pass down into *I*. This device comprises two separate parts in which the solvents pass in opposite directions and permits the condensation of parts of the vapors and reheats the cold air used for condensation. The vapors then pass through a condenser *J* where they are further purified and condensed. At the outlet of the last condenser *K*, the purified cold air passes back into the second compartment of the exchanger *I* where its temperature rises. It is then forced by a fan *L* into a reheater *M* fed by hot water from condensed steam from the drying table *C*. The air from this reheater may be returned directly to the hood through a pipe *N* if the temperature is sufficiently high, or it may be delivered to a second heater *O* through the pipe *P*. A tube *Q* is provided for the introduction of free air if desired. Another tube *R* is supplied for the escape of air by the opening of a two-way cock. The installation also comprises measuring apparatus, valves, etc., and a pipe *S* for isolating the heater *O*. It will be understood that all uncondensed

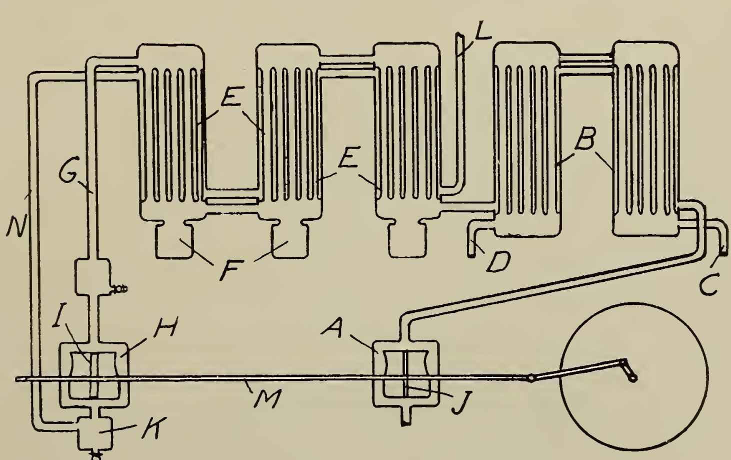


Fig. 235.—The Heinzerling Apparatus.

vapors are returned to the hood by the confined air, thus resulting in a theoretical total recovery of the solvents. The solvents recovered on the first round pass off through pipes *T* and *U* into a suitable closed vessel, while the uncondensed vapors are returned to the heaters and coolers.

The Heinzerling Apparatus.

In the solvent recovery apparatus, shown in Fig. 235, air is compressed by a pump *A*, which forces it into a coil of pipes in a condensing chamber *B*, cooled by water entering at *C* and leaving the condenser at *D*. The compressed and cooled air then passes through tubes in the condensing chambers *E* and the vapors which condense are collected in receptacles *F*. The compressed air next passes through the pipe *G* into a cylinder *H*, where it expands and drives the piston *I* connected by a rod *M* with the compressing piston *J* in the cylinder *A*. A still further fall of temperature is thus produced, and the vapor condensed thereby collects in a receiver *K*. The expanded and cool air then passes back through the pipe *N* to the condensers *E* where it cools the vapor and air which has collected therein. The air finally escapes through the pipe *L*.

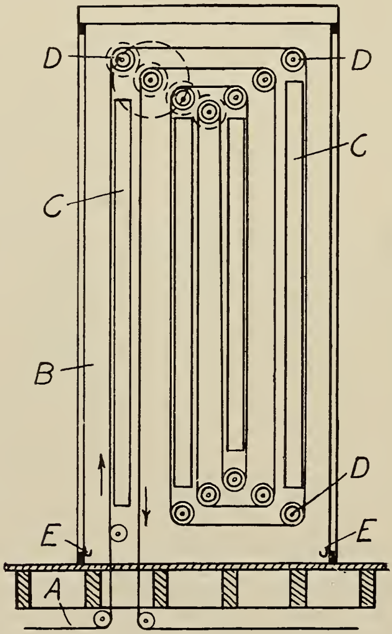


Fig. 236.—The Spenle Solvent Recovery Machine.

THE SPENLE SOLVENT RECOVERY MACHINE.

The apparatus shown in Fig. 236 recovers the solvents during the process of drying. The fabric *A* passes directly from the spreading machine into the vertical drying chamber *B* which is heated by steam chests or pipes *C*. It passes around guide rollers *D* in such a manner that the coated side of the fabric does not come in contact with the rollers until sufficiently dried to prevent sticking. The fabric passes out at the lower end of the dryer and to a wind-up roller in the usual manner. The walls of the drying chamber *B* are cooled by water pipes, while the top of the dryer is heated to prevent condensation directly above the drying fabric. The condensed solvent collects on the side walls of the dryer and runs down into the troughs *E*, from which points it is drained off and collected for reuse.

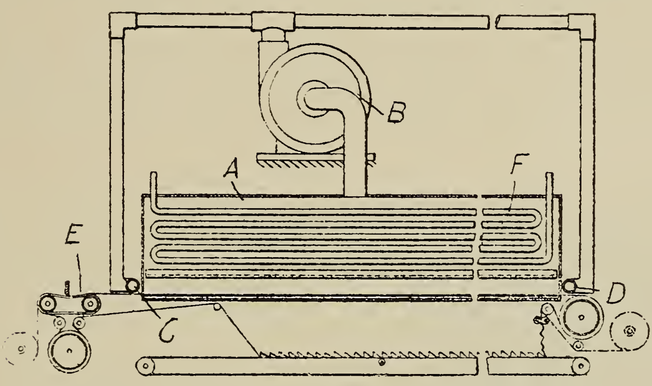


FIG. 237.—THE SPENLE SOLVENT RECOVERY MACHINE.

Another solvent recovery apparatus designed by Spenle is shown in Fig. 237 applied to a horizontal dryer. An outlet at the upper end of the drying chamber *A* is connected with a suction fan *B*. Adjacent to the openings where the fabric enters and leaves the chamber are pipes *C* and *D* which direct the air on the fabric *E* as the latter enters and leaves the chamber *A*. To accomplish this the pipes *C* and *D* have slots or ports in their lower sides, and the air received by the fan is circulated back into the drying chamber. The suction and delivery connections of the fan are so proportioned that the air flowing over the cooling pipes *F* travels at low speed to insure perfect condensation of the vapors. Also, the jets of air from the pipes *C* and *D* are sufficiently strong to prevent the escape of vapor.

THE BOECLER SOLVENT RECOVERY APPARATUS.

Fig. 238 shows a side elevation and a cross-section of the device in connection with an ordinary horizontal spreader. The hood *A*

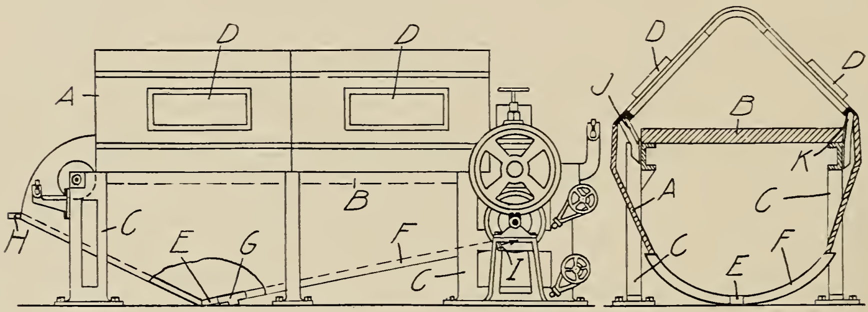


FIG. 238.—THE BOECLER SOLVENT RECOVERY APPARATUS.

completely surrounds the table *B* of the spreader, dividing it into an upper and lower compartment. The supports *C* of the table project through the hood, and at these points the hood is flanged and made

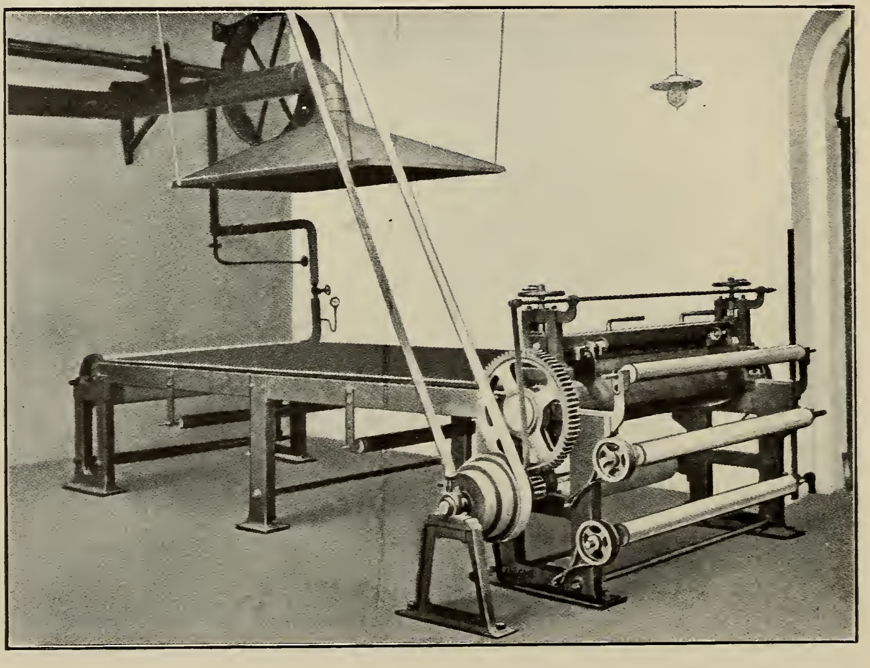


FIG. 239.—EXHAUST HOOD FOR SOLVENT VAPORS.

air-tight. The upper compartment has transparent windows *D*, which permit the operation to be observed without opening the hood. The sides of the lower compartment are inclined so that the condensed solvents will flow to the exit *E*. These lower walls are water-jacketed at *F*, the cooling water entering at G and flowing out at H and *I*. The vapors which arise from the spreader table *B* cannot escape on account of the hood. They therefore partly condense and flow down the sides, escaping through passages *J* and *K* into the lower compartment.

Exhaust Hood for Solvent Vapors.

Fig. 239 shows a horizontal spreader with a large funnel-shaped device suspended directly over the drying table and connected by a flue or pipe with an exhaust fan. When the proofed fabric is started across the drying table the vapors rise and the fan creates a steady draught which causes them to pass upward into the funnel, to the solvent recovery apparatus. This apparatus may be any of the types described above for receiving the vapors and condensing them.

CHAPTER XIV.

CEMENT AND SOLUTION MACHINERY.

WHILE the amount of rubber cement produced is very large, there is no complicated machinery used. The churn mixer or muddler is the principal appliance and its office is to put massed or compounded rubber into solution with naphtha.

A common design for a cement mixer is a cylindrical tank with a bolted-on top, and a hand-hole for introducing the material. On the front near the bottom is a gate valve for drawing out the cement. The lower end of a vertical shaft, provided with stirring paddles, rests in a step bearing in the center of the tank at the bottom. The upper end is journaled in the cover and driven by bevel gears and a cross shaft. The tight and loose pulleys on this shaft are driven from an overhead counter-shaft.

In cement that is made for spreader work or for outside trades, the following procedure is followed. The rubber is washed and dried in the usual manner. It is then masticated or massed and put into churns or muddlers, or a dough machine, or in a masticator with the solvent. From there, if necessary, it goes through hydraulic strainers and then it is ready for use.

Almost all manufacturers of rubber goods are makers of cement for their own use. Where small quantities of cement for special compounds are to be made large sheet iron tubes are usually employed, the mixed sheet being first well softened by heat, and then cut up into a sufficient quantity of whatever solvent is to be used. A rapid stirring greatly facilitates the action of the solvent, but good cement needs several hours of digestion before it is fit for use. Where larger quantities are to be made, iron tubs are partly filled with the solvent, which is, in most cases naphtha, and the rubber is run through the "refining mill," coming out in thin sheets, which are cut off and plunged, warm as they are, into the tub of liquid, the whole mass being meanwhile rapidly stirred. In large factories where great quantities of cement are used, machinery is employed to do the stirring.

Cement Muddler.

The machine illustrated in Fig. 240 is the ordinary muddler and is used for mixing cement in large quantities. It is a cylinder mounted

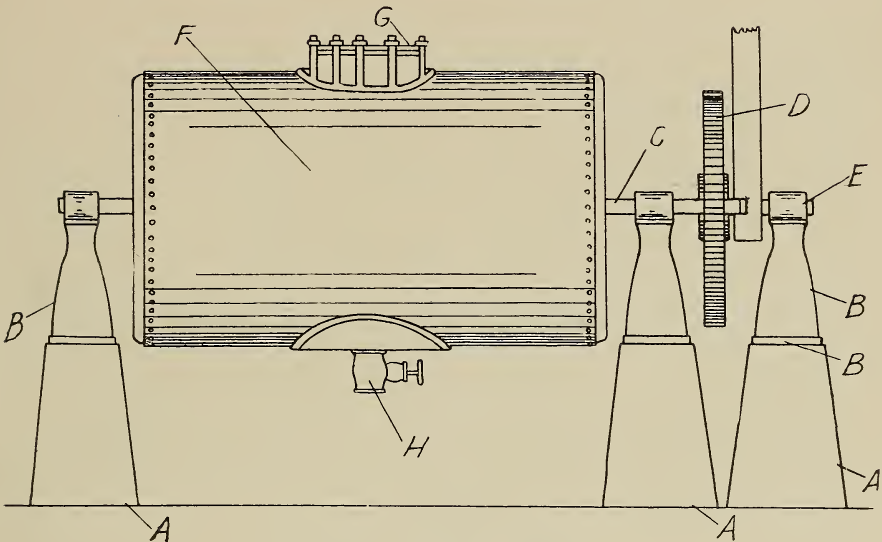


FIG. 240.—CEMENT MUDDLER.

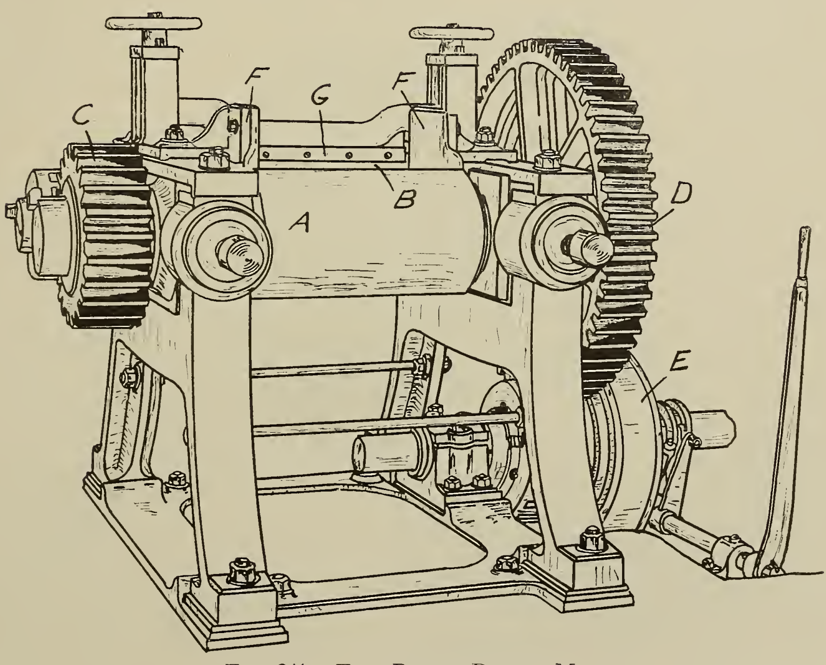


FIG. 241.—THE BRIDGE DOUGH MILL.

on concrete foundation *A* supporting frames *B* in which is journaled the main shaft *C*. This is driven by spur gear *D* from a belt driven pinion shaft *E*. The cylinder *F* revolves with the main shaft *C* at the rate of 15 R. P. M. and has an opening for filling at *G* and a gate valve *H* for discharging. A variety of simple stirring devices are used taking the form usually of longitudinal blades attached to the sides of the cylinder.

The Bridge Dough Mill.

The dough mixing mill shown in Fig. 241 is of the same general design as the ordinary rubber grinding and mixing machine but it has special adjustable attachments to facilitate and improve the mixing. The rolls *A* and *B* are connected together by friction gears *C*, which revolve the adjustable front roll *A* at a surface speed less than that of the drive roll *B*. The latter is driven by the large spur gear *D* that meshes with a driving pinion on the shaft of the friction clutch *E*. Between the rolls are two guides *F* which keep the dough from the roll ends. Above the roll *B* is an adjustable doctor *G*, which scrapes the dough from the rolls.

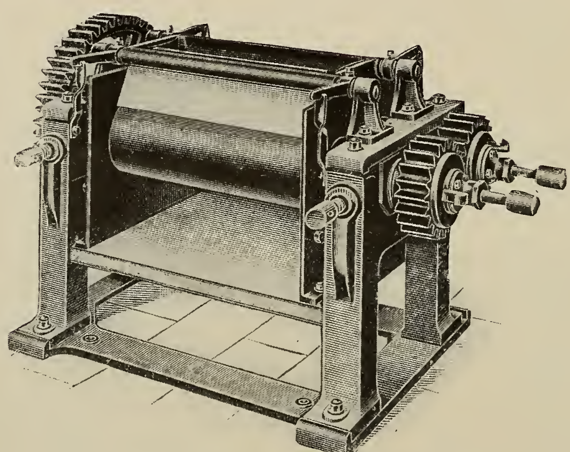


Fig. 242.—The Bertram Dough Mill.

The "Universal" Solution Mixer.

Fig. 243 illustrates the Werner & Pfleiderer kneading and mixing machine. The view on the left shows the machine closed, while the right shows it open for discharging. The mixing trough is supported on two side frames with bearings for the driving shaft. On the outer

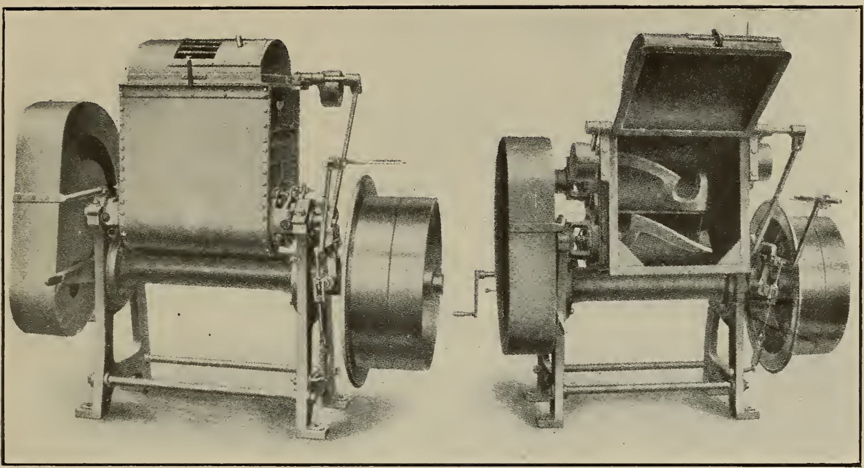


Fig. 243.—"Universal" Solution Mixer.

end of the main shaft is keyed a pinion which engages a spur gear keyed to the end of one blade shaft. This extends through the trough, which swings upon it when the machine is to be emptied. The other blade shaft is parallel to the first but runs in bearings fastened to the trough itself and driven from the first shaft by a spur gear and pinion. The two shafts with their steel blades turn toward each

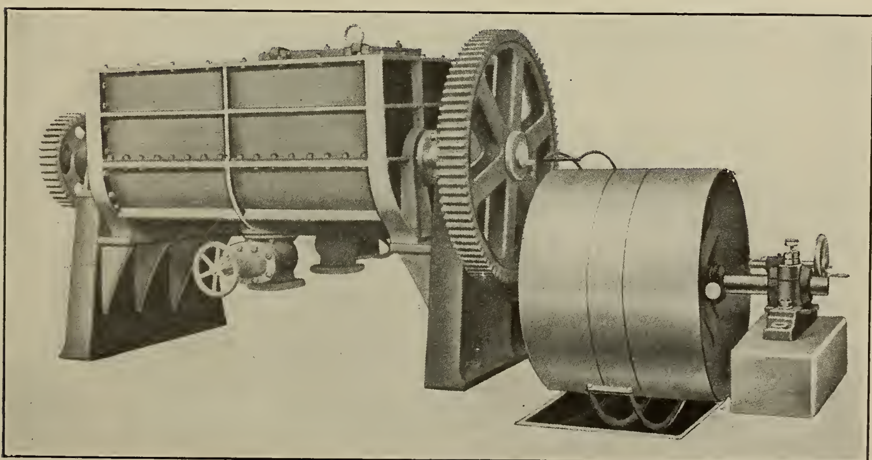


Fig. 244.—The Befstorff Solution Mixer.

other in the trough at the same rate of speed. The trough is jacketed for heating by steam or cooling with water. Stuffing boxes for the blade shafts are arranged to prevent cement leakages and to keep lubricating oil from entering the trough. The machine is belt driven and has a two-speed gear for driving the blades at low speed when the mass is heavy and at a high speed to finish off quickly when the mass has been reduced sufficiently. To empty the machine the trough is turned forward by a hand crank and the hinged top, which is counterbalanced at the rear, opens by the same motion. A hinged lip guides the solution into the receptacle. These machines are made in various sizes from 1 to 200 gallons capacity.

Change Can Cement Mixer.

In the machine shown in Fig. 245 a can containing the finished cement is taken from the machine and another one substituted. The

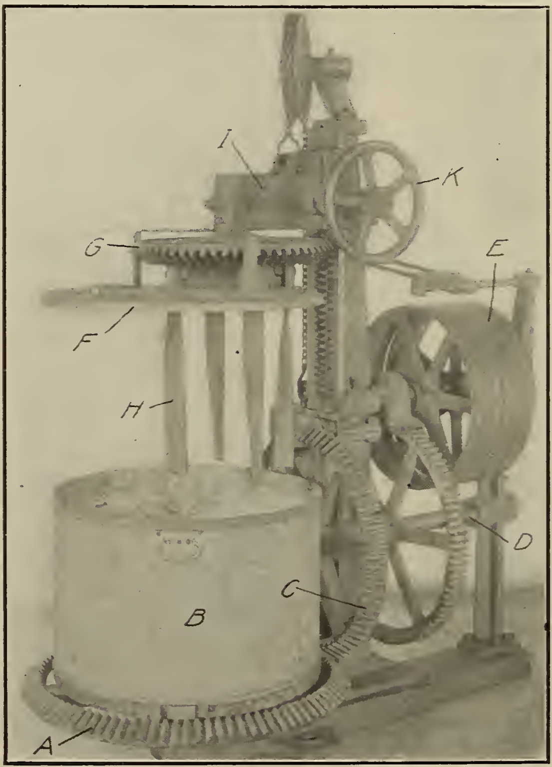


Fig. 245.—Change Can Cement Mixer.

base of the machine has a step bearing in which revolves a short vertical shaft supporting the platform. This is really a large bevel gear *A*, on which the can *B* is placed. It is driven by a bevel gear *C* mounted on shaft *D*. This is driven by a spur gear and pinion from the driving shaft, revolved by belt pulley *E* from an overhead countershaft. *F* is the cover to which is attached bevel gear *G* and also four stirring blades *H*. The bevel gear *G* is keyed to a short shaft which revolves in a bearing that forms a part of the sliding head *I*. To operate the machine, can *B*, containing the rubber and solvent, is placed in position and sliding head *I* and cover *F*, with its bevel gear and stirring blades *H*, is lowered into the can by handwheel *K* operating a rack and pinion. The bevel gear *G* meshes with gear *C*, and when power is applied the can is driven in one direction and the stirring blades in another. The sliding-head *I* has a counterweight so that the cover and blades are easily raised when the operation is finished.

Twin Solution Churns.

Fig. 246 illustrates the Ross twin solution mixer, of the overdriven beater type. Two tanks are supported a short distance above the floor so that the solution can be drawn off through the sliding gate

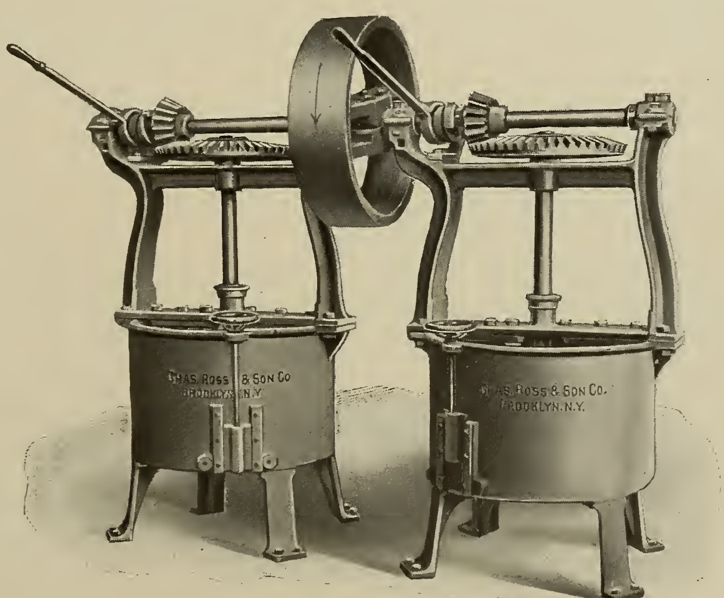


Fig. 246.—Twin Solution Churns.

valves. The vertical shafts are journaled in bearings centrally located in the framework bolted to the tanks. These have stirring blades at their lower ends and are driven by bevel gears keyed to the top ends, and are, in turn, driven by pinions keyed to the horizontal shaft. This is driven by belt pulleys and has two claw clutches so that each machine can be started and stopped independently. The tanks are open at the top and have steam connections.

The Troester Solution Churn.

Fig. 247 shows a German type of churn. It consists of a cylindrical tank supported on an open base. A cover is bolted to the tank

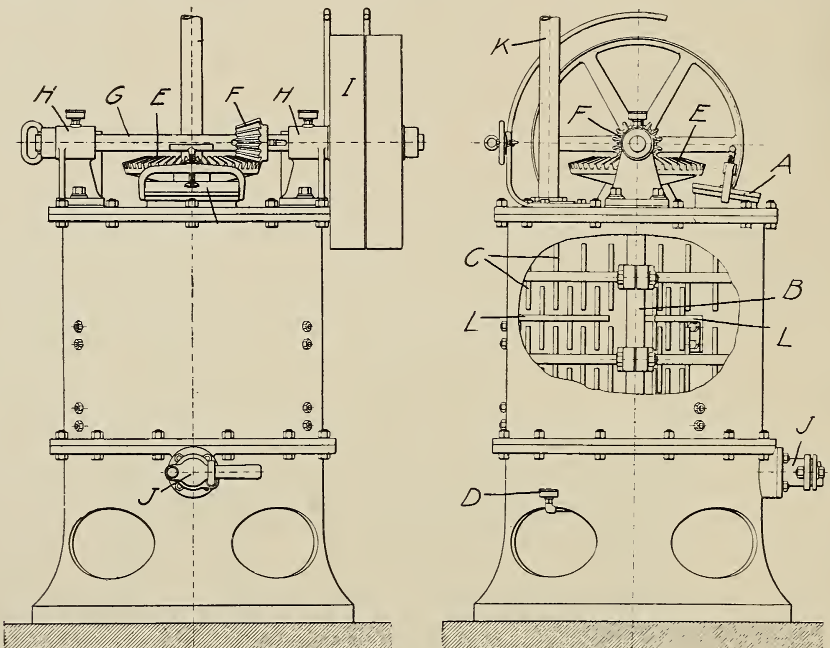


Fig. 247.—The Troester Solution Churn.

and has a handhole *A*, through which the rubber and solvent are introduced. The vertical shaft *B* carries stirring paddles *C* which pass between blades *L* attached to the sides of the tank. The lower end rests in a step bearing in the center of the tank at the bottom. This bearing is lubricated by grease cup *D*. The upper end of the shaft is journaled in the cover and driven by a bevel gear *E*, engaging a bevel pinion *F* keyed to the cross shaft *G*. This shaft has bearings *H* bolted to the cover and is driven by belt pulley *I* from an over-

head countershaft. The solution is drawn off through the valve *J*, and the vapor is conducted by pipe *K* to an open air vent or to a solvent recovery apparatus. These churns are made with a capacity of 13 to 65 gallons.

The Bridge Solution Pans.

Fig. 248 shows a beater type on the right and on the left is an under-driven machine. The base *A* supports in two bearings the main driving shaft, driven by pulley *B*, from an overhead counter-

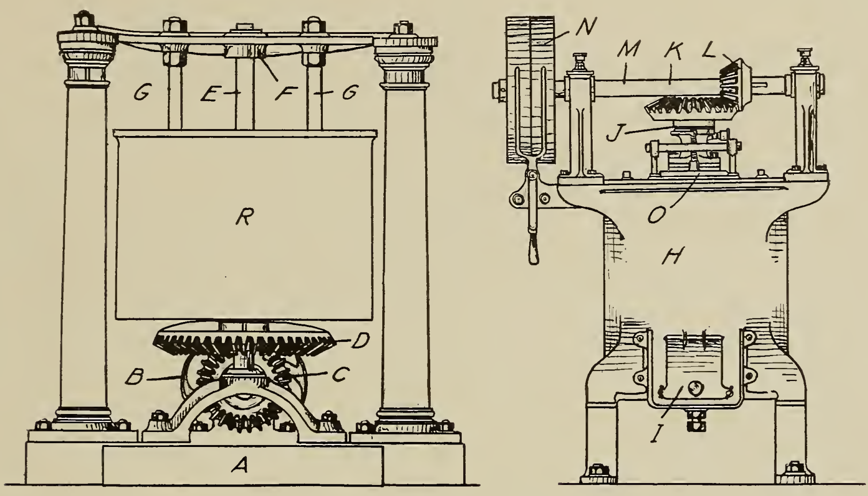


Fig. 248.—The Bridge Solution Pans.

shaft. On the end of this shaft is keyed a bevel gear *C* which drives a larger bevel gear *D*, keyed to the vertical shaft *E*, which is journaled in the top frame at *F*. Two mixing cones roll on the bottom of the pan and are held in position by two guards *G* suspended from the top frame. The pan *R* revolves with the large gear *D* and the dough is thoroughly mixed by the rolling cones.

In the drawing on the right, tank *H* is supported above the floor so that the solution can be drawn off through gate valve *I*. The tank has a vertical shaft resting in step bearing at the bottom and supported at its upper end by the central bearing *J*, bolted to the cover. The beater blades are rigidly attached to this shaft, which is driven by a bevel gear *K* meshing with a pinion *L* keyed to the horizontal driving shaft *M*. This is driven by pulleys *N* from an overhead countershaft. The cover has a handhole *O*, through which the machine is filled.

The Drew Solution Mixer.

The Drew mixer, Fig. 249, consists of cylindrical tank *A*, cylinder *B*, and a reciprocating plunger *C*, which draws the rubber solution through a sieve *D*. The softened rubber and solvent are put in the reservoir *A* and the up stroke of the plunger draws the solution into the cylinder. The valves in the plunger open when it descends and the solution in the lower end of the cylinder passes to the upper end. The next up-stroke draws a new charge through the sieve and delivers the first charge through the pipe *E* and valve *F* back into the reservoir. A continual circulation is maintained through the sieve until the con-

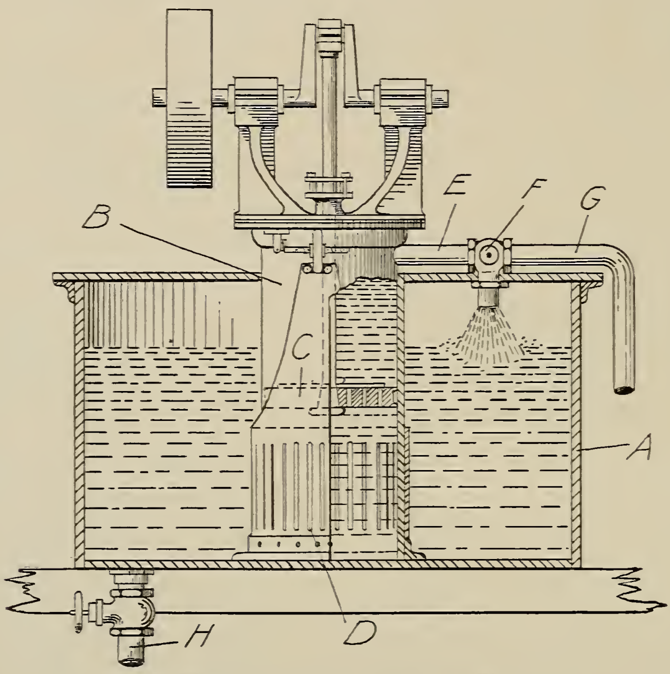


Fig. 249.—The Drew Solution Mixer.

tents of the tank are thoroughly mixed. By turning the three-way valve *F*, samples of the solution may be taken through the pipe *G* during the operation. The tank is drained through pipe *H*.

Simple Solution Strainer.

One of the simplest forms of solution strainer is shown in Fig. 250. It consists of a single roller fixed in the bottom of a wooden hopper, against which press adjustable slides, fitted with leather strips. The roller is mounted on cast iron standards and driven by a belt

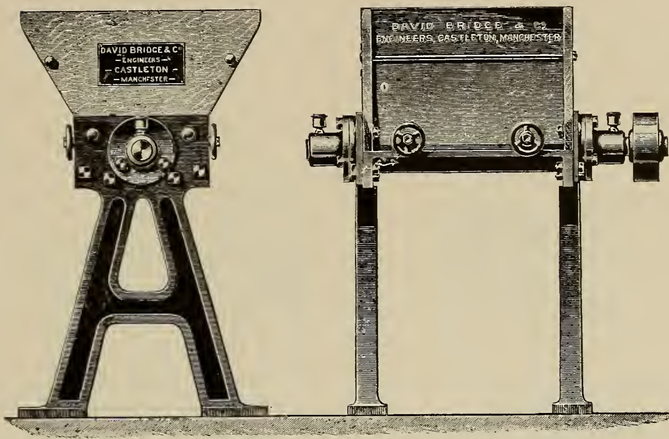


FIG. 250.—SIMPLE FORM OF SOLUTION STRAINER.

pulley. Provision is made to prevent the oil used for lubrication of the bearings from getting inside the hopper. The machine is sufficiently high to admit of a good sized tank being placed underneath.

SCREW TYPE STRAINER.

Fig. 251 shows two views of Bridge's solution strainer, of the screw type. It consists of an accurately bored cast iron cylinder, about sixteen inches in diameter and eighteen inches deep, with a removable perforated bottom. The cylinder is mounted on strong standards of sufficient height to admit a can beneath. Over the perforated plate, fine removable copper gauze discs are fitted. After the cylinder has been charged, the cement is forced through the strainer by a tight fitting plunger and screw driven by belt and worm gearing. When the plunger has reached the bottom the machine is automatically stopped and the plunger quickly lifted by a handwheel.

HYDRAULIC STRAINER.

Fig. 252 shows Bridge's hydraulic solution strainer. It is supported at a distance above the floor so that the solution is strained directly into a receptacle. The hydraulic cylinder *A* is mounted on the main body of the machine and the lower end of the piston *B* is adapted to fit the cylinder *C* in which the solution is placed. This chamber has a removable, perforated bottom plate, over which fine copper gauze discs are fitted. After the cylinder has been charged, the piston, operated by hydraulic pressure, forces the solution through the strainer. A three-way valve, operated by a handwheel *D*, controls

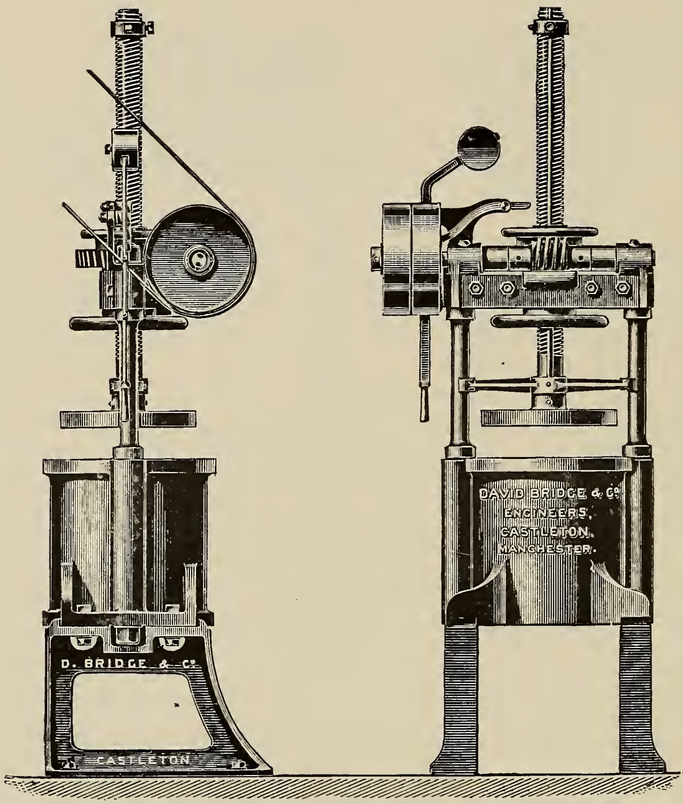


Fig. 251.—Screw Type Strainer.

the movement of the ram. The chamber C is provided with steam connections for heating the solution.

Machine for Filling Tubes.

Fig. 253 is a side elevation and Fig. 254 a plan view of Brett's machine for filling cement tubes. A is the reservoir and B the pump for filling the tubes. C is a pipe connecting the reservoir A with the end of the pump cylinder. D is a valve fitted in the pipe C, and E is a small sliding valve at the top of pipe C, controlled by an external handle F. H is the piston on the end of the piston rod I, and J is the piston valve, K is a nozzle upon which is placed the collapsible tube L. The nozzle is screwed to a projection on the sleeve M, which slides on the front end of the cylinder B, which communicates with the nozzle through a hole, when the sleeve is placed in such a position that the nozzle comes opposite the hole. By sliding the sleeve upon the end of the cylinder it can be brought opposite a by-pass in the under

side of the cylinder, to allow the solution to escape. A slide valve *N* controls the flow of the solution from the cylinder *B* into the tube *L*. The solution is stirred in the tank *A* by the arms *O*, mounted upon a vertical spindle *P* and rotated through bevel gears *Q* operated by a handle *R*. Stationary arms *S* are attached to the sides of the tank, and the arms *O* revolve between them.

In filling the tubes the valves *D* and *E* are opened and the lever *T* is pressed forward, drawing a supply of solution from the reservoir into the cylinder *B*. The piston is then pulled back and the solution passes through the piston valve *J* and fills the cylinder. When the piston is again pressed forward, and valve *N* being held closed by a spring *U*, the solution offers resistance to the forward motion of the piston. This extra pressure moves the links *V*, *W*, *X* and *Y* and pushes the sliding valve *N* inward so that the passages are uncovered. The solution now passes through nozzle *K* into the tube *L*, while the overflow escapes through the by-pass. The operator releases the handle and the spring *U* closes the valve *N*, so that the tube may be removed without loss of solution.

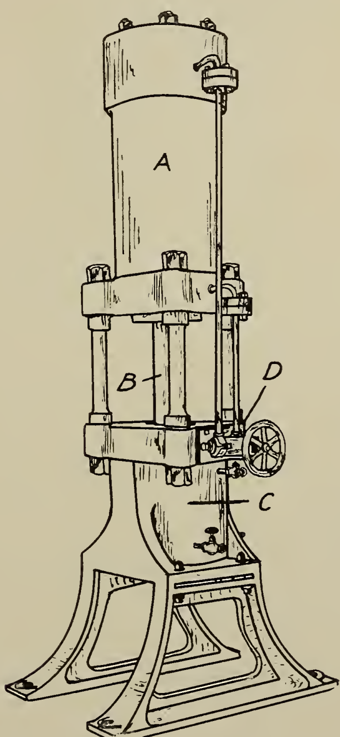


FIG. 252.—HYDRAULIC STRAINER.

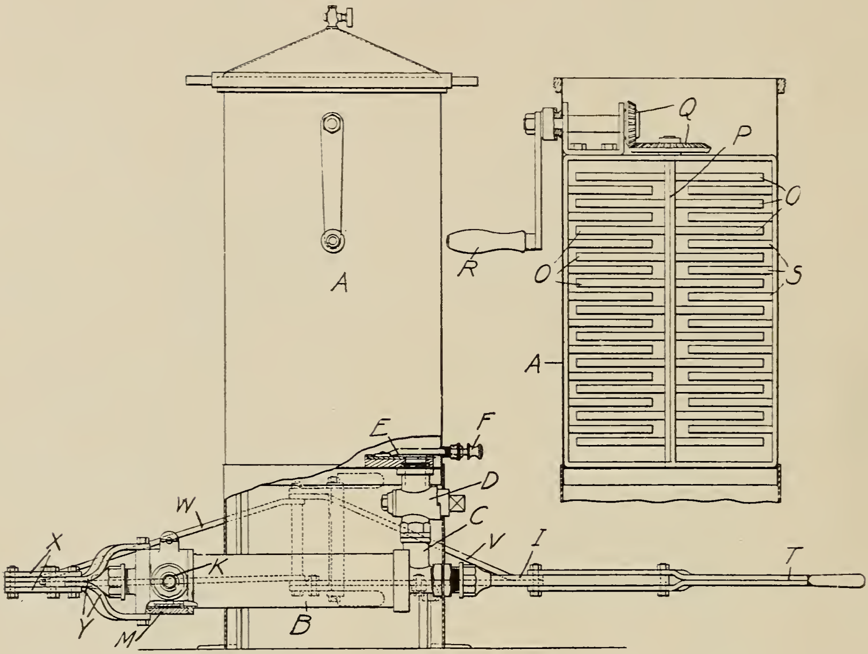


FIG. 253.—SIDE VIEW OF THE BRETT MACHINE FOR FILLING TUBES.

It is admitted in all factories where the article is used that cement is a dangerous servant. In most well regulated places the mixing and stirring of cement is done in a fireproof building, known as the cement-house. This may be near the factory to receive the benefit of

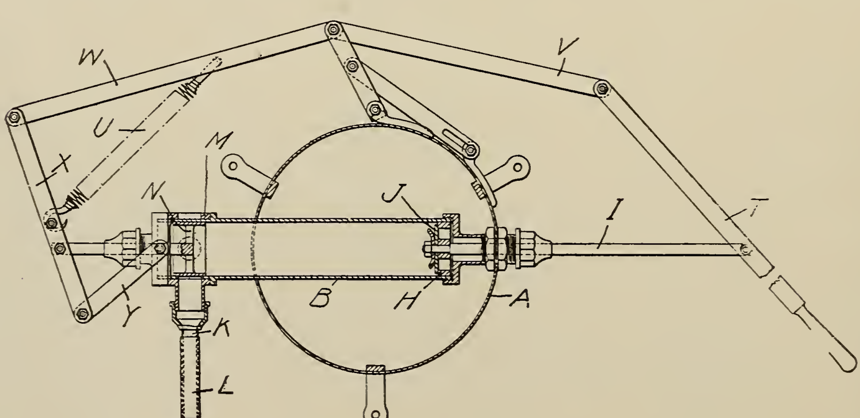


FIG. 254.—PLAN VIEW OF THE BRETT MACHINE.

the steam power, and yet be so distant and protected as to be harmless either from sudden explosion, or fire from any other cause.

The Bowser Cement Can.

The rubber cement can shown in Fig. 255 is of the portable type, comprising a heavy metal tank to which is attached a brass suction pump. It is designed for distributing cement to the various departments of a rubber factory. The pump will discharge at one stroke, an accurate pint, half-pint or quarter-pint. It has an anti-drip nozzle with a lever shut-off, which cuts off the flow when pumping ceases and

Fig. 255.—The Bowser Cement Can.

prevents deterioration of the cement. The cover has four open lugs in which fit the swinging bolts attached to the can, and is tightened by four winged nuts. A hand hole and a vent are also provided in the cover.

The Bowser Cement Storage Tank.

The tank shown in Fig. 256 is for storing and measuring rubber cement. It is a rectangular metal tank, fitted with a combination suction and force pump. This will discharge at one stroke a gallon, half-gallon, quart or pint at the will of the operator. The tank has a flanged connection containing an automatic vent valve, which terminates in an air vent protector at some point outside of the building. The tank

has a sloping bottom which causes the liquid to flow into a pocket containing the foot valve of the pump. thus permitting all of the cement to be drawn off. A hand hole is placed in the front near the bottom,

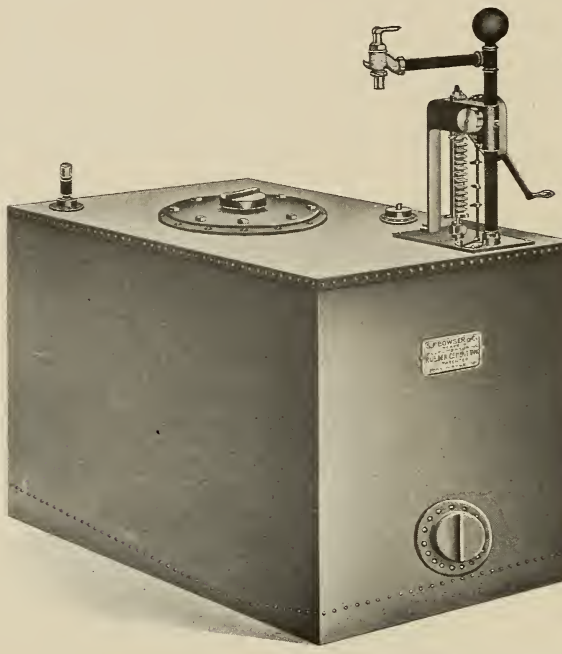


Fig. 256.—The Bowser Cement Storage Tank.

so that it may be cleaned out. Tanks having a capacity of four barrels or more have two clean-out openings.

Battery Storage Outfit.

Fig. 257 shows a battery of six self-measuring cement storage tanks, equipped with a barrel cradle. track and chain-hoists for storing and handling cement in large quantities. The barrel is placed on the cradle, raised into position by means of the hoist, then rolled into place over any tank, and the contents transferred to the tank by gravity. Splashing and waste are prevented by the barrel dash. This arrangement makes unnecessary the use of a transfer pump. The whole equipment is air-tight. The action of the pumps in drawing the cement from the bottom of the tanks tends to keep the contents agitated, thus maintaining a uniform consistency.

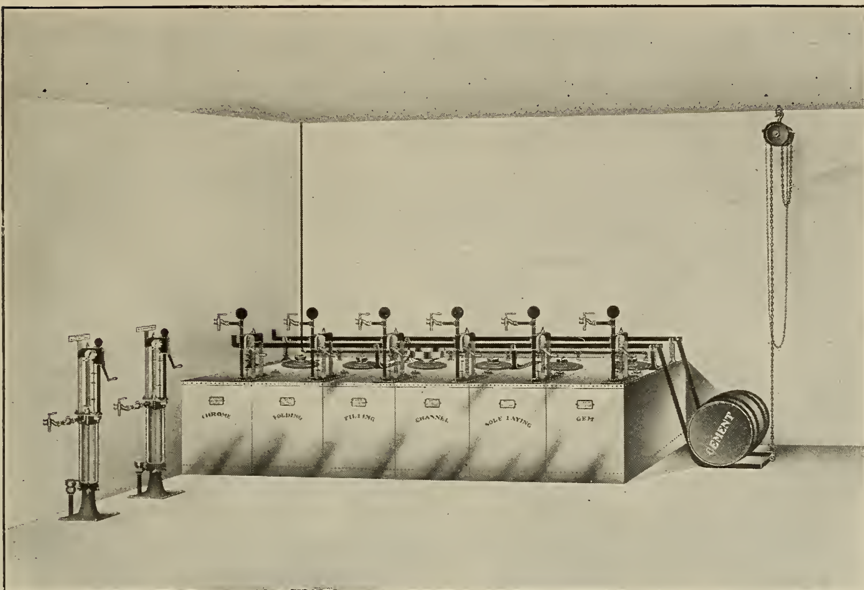


FIG. 257.—BATTERY STORAGE OUTFIT.

NAPHTHA STORAGE.

The Bowser equipment in Fig. 258 consists of an underground naphtha tank and fill pipe running to a point accessible to the supply.

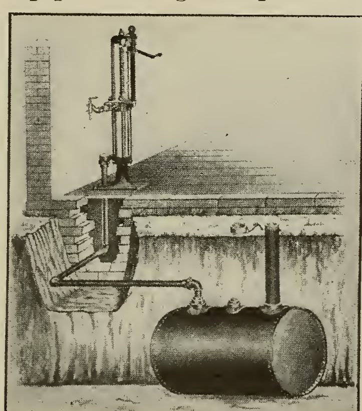


FIG. 258.—NAPHTHA TANK AND PUMP.

A hand pump, placed inside the building, accurately measures gallons, half gallons, quarts and pints at a stroke. It can be adjusted to deliver any intermediate quantity. A gage on the tank indicates the amount remaining in the tank and is a check on the delivery.

CHAPTER XV.

EXTRACTION OF RUBBER AND GUTTA FROM SHRUBS, VINES, ROOTS AND LEAVES.

THE extraction of rubber from Guayule shrubs, vines and roots and gutta from leaves, has been of great interest and importance. It has been most successfully done near the source of supply, although Guayule shrub sent to the United States and Germany has been successfully extracted. It is only when the rubber appears in the form of rubber in a plant and not in the form of latex, however, that this extraction from dried plants has been even remotely successful.

Certain types of rubber producers, namely, African vines and Mexican shrubs, are susceptible to the extraction of the rubber contained in them by mechanical means. It is only in Mexico, in connection with the Guayule plant, that this has been done on a large scale.

Guayule.

The ordinary process for extracting Guayule from the shrub is as follows: The bales from the field are opened and the shrub fed by hand to the crushers, small end first, the crushers being flooded with water. The crushed shrub then goes to a pebble mill, the charge being 6 bushels to 150 gallons of water. From there the pulverized mass is floated to skimming tanks. Here the rubber and light bark float and the heavy wood fiber sinks. The rubber and bark is then floated off to another tank and into a revolving screen, where the dirty water is got rid of. Then it goes to a compression tank where the bark is settled; then to an ordinary tub washer and finally to a two-roll rubber washer—after which it is dried.

There are other systems; for example, extracting the rubber by alkaline baths or by solvents. There are also many types of crushers, disintegrators and extractors.

Guayule Shredder.

The Williams machine for cutting and shredding Guayule shrub is illustrated in Fig. 259. The shrub is thrown on a traveling feeder *A*, which carries it along until it comes in contact with the lower side of the presser *B*. This is in the form of a traveling apron driven

by a sprocket chain passing over sprockets *C* and *D*. The sprocket wheel *D* is adjustable to accommodate the varying bulk of the shrub. The discharge end of the apron *B* rises as the material passes through, and this raises the feed roller *E* by the chain *F*. This feed roller forces the shrub over the stationary cutting knife *G*. The loosely jointed beaters *H* are placed in rows on the shaft. They are extended by centrifugal force and cut off the shrub according to the speed of the feed rollers and the apron *B*. If metal or other foreign material

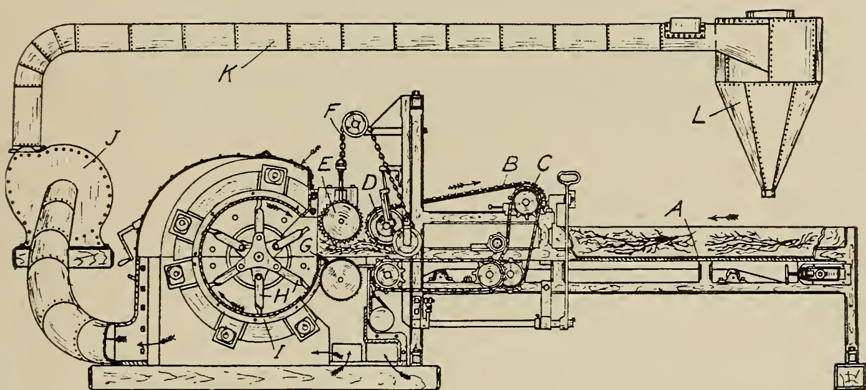


Fig. 259.—Guayule Shredder.

is fed in with the shrub the machine stops automatically. The cut shrub falls on the perforated iron screen *I*, where the work of pulverizing is finished. The fine material falls through the screen and is taken up by the fan *J* and forced through the pipe *K* into the dust separator *L*. Here the dust is separated from the shrub containing the gum.

Rotary Cutter.

The Abbe rotary cutter, shown in Fig. 260, cuts roots, vines or shrubs to any size, before feeding to the pulverizer. The machine consists of a cylindrical casing *A* in which five knives *B* revolve against six stationary knives *C* set inside the casing, three on each side. The knives are set at a slight angle, giving a shearing action. The shrub is fed into the hopper *D*, and cut by the knives which carry it over the perforated bottom plate *E*. If fine enough it falls through, otherwise it is carried up and recut until sufficiently reduced to pass through the perforations. The fineness depends wholly on the size of the holes in the plate. The knives are adjustable and the plate *E* is removable.

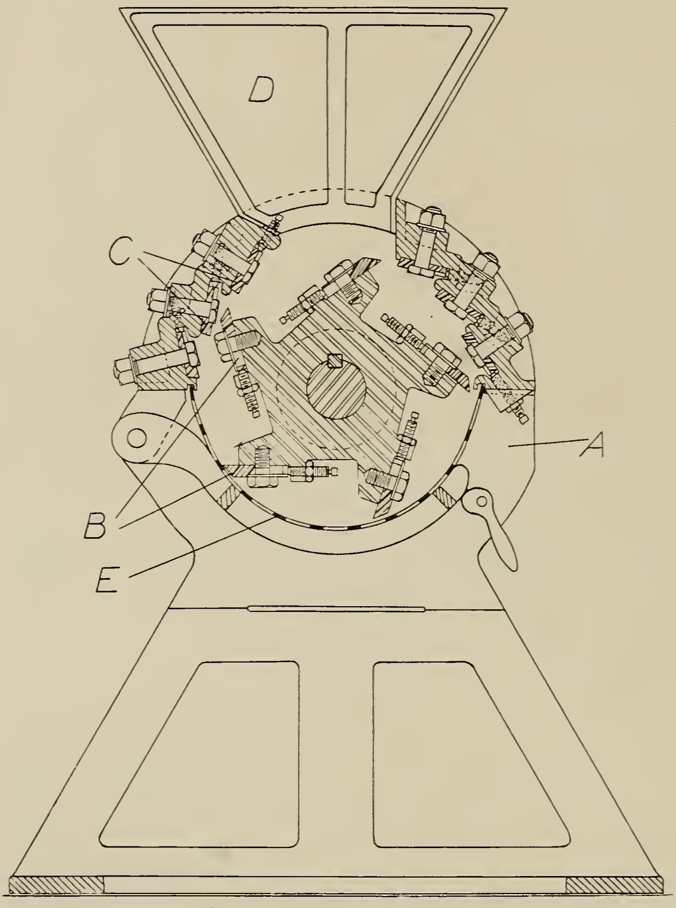


Fig. 260.—Rotary Cutter.

The Abbe Pebble Mill.

Pebble mills grind by friction, produced by a great number of flint pebbles or porcelain balls tumbling and rolling inside a revolving cylinder.

Fig. 261 shows a pebble mill for reducing Guayule. It is an iron cylinder set on trunions, revolved by spur gears from a belt pulley, and has steam or air connections for grinding under pressure. The cylinder is porcelain lined and has a flanged manhole to which a tight cover or discharging screens may be bolted. The material is placed in the cylinder with the pebbles and the cover bolted on.

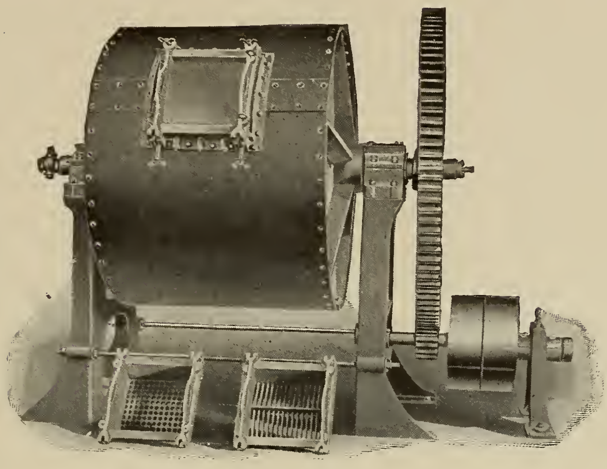


Fig. 261.—The Abbe Pebble Mill.

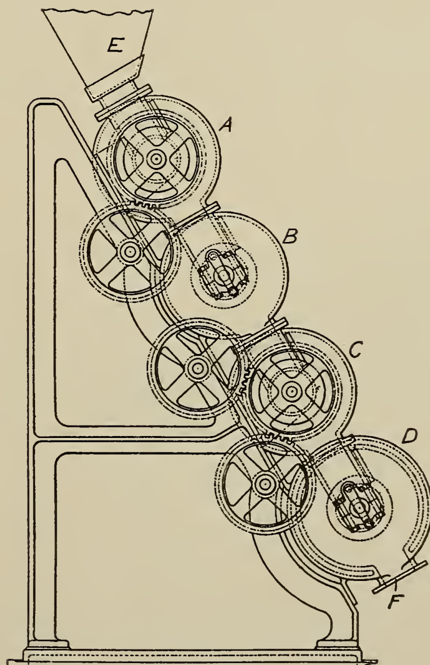


Fig. 262.—The De La Corte Crusher.

The mill is revolved until the material is sufficiently reduced, when it is discharged through the screen.

The De La Corte Crusher.

Fig. 262 shows four cylinders *A, B, C* and *D,* each of which contains a spiral feeder. The shrub is first broken up in short pieces and fed into one end of cylinder *A* from a hopper *E* and conveyed to the opposite end where it passes between a set of grinding discs. These partially crush it, after which it falls into the end of cylinder *B* and is conveyed to the opposite end, where it passes between another set of discs. This operation is repeated in *C* and the pulverized shrub, having reached the grinding end of cylinder *D,* is discharged through the opening *F.* The surface of the grinding discs vary from coarse in the first set to fine in the last. The final cylinder *D* is heated to assist in massing the particles of rubber wood fiber. By the time the material reaches the outlet *F* the wood fiber has been thoroughly ground and the rubber is then separated from it by washing. A means is provided for adjusting the distance between the grinding discs so that any desired pressure may be exerted.

The Bridge Guayule Crushers.

The drawings *A* and *B* in Fig. 263 show two types of machines for extracting rubber from Guayule and similar shrubs. In *A* the

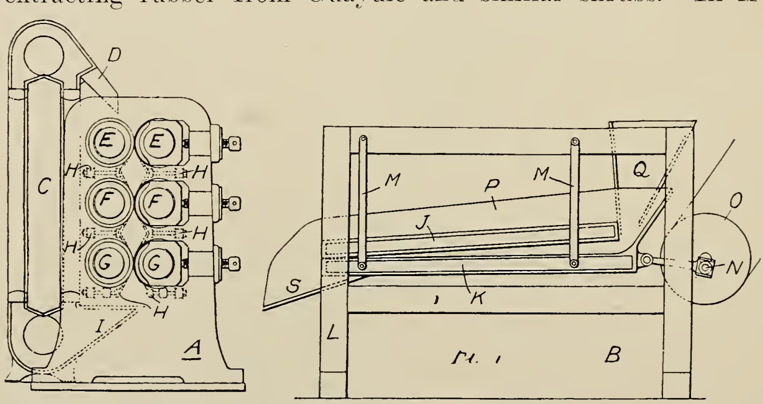


Fig. 263.—The Bridge Guayule Crushers.

shrub is delivered to the rolls through the chute *D* by an endless chain of elevator buckets in a casing *C.* The shrub passes between the corrugated rolls *E E, F F* and *G G,* which crush and disintegrate the woody fiber. A stream of hot water is played over it and amalgamates

the rubber while the waste is washed away. The scrapers *H* prevent the rubber from sticking to the rolls. To send the shrub through the machine a second time, a hopper *I* is placed to catch it as it leaves the rolls *G* and the moving buckets convey it again to the top of the machine.

In the second machine, *B*, the crushing is done by a pair of plates. The plate *J* is stationary in the frame *L* with the front end higher than the back, while the plate *K* is level and suspended by two swinging supports *M* pivoted to the upper part of the frame. The forward end of the plate is attached to a connecting rod pivoted on a crank *N*. When the latter is turned by the driving pulley *O*, the plate *K* is reciprocated horizontally and the shrub is crushed between the plates. The lower plate has sides *P* to retain the material as it is fed from the hopper *Q*, and it is ground finer and finer as it approaches the rear end of the machine until it passes out into a receiver under the chute *S*. The plates are chambered for steam and air is blown between them to remove the light bark and wood fibers.

The Lawrence Extractor.

In Fig. 264, crushed Guayule shrub is delivered from a chute *D* to a tank *A* containing boiling water, heated by steam coils *B*, and agitated by steam from the pipe *C*. It is boiled for half an hour and then drained off through the outlet pipes *E* and *F*. These pipes

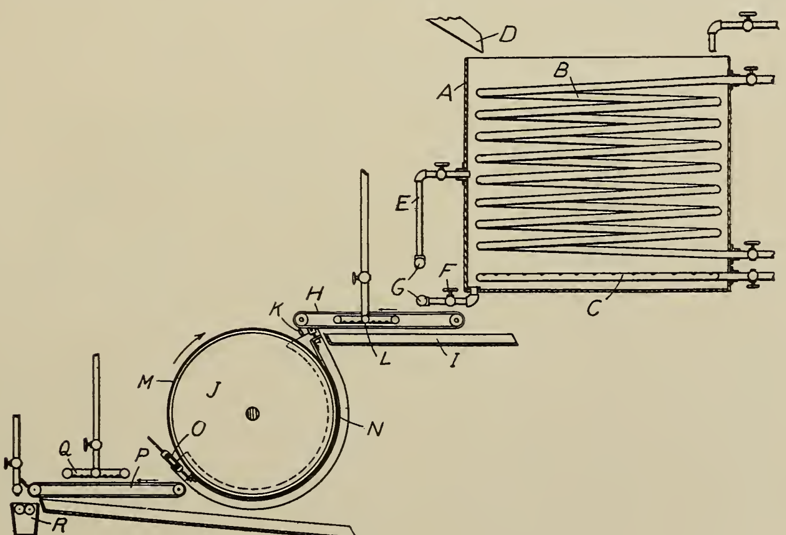


Fig. 264.—The Lawrence Extractor.

are fitted with horizontal, perforated tubes *G,* through which the mixture falls on a moving apron *H.* The water drains off through the apron into a trough *I,* while the shrub particles are carried along to the separator *J.* A scraper *K* and a sprinkler *L* serve to detach any particles which adhere to the apron.

The separator is covered with a band of thick rubber belting *M* slightly roughened on its outer surface. An apron *N* of similar material surrounds a portion of the drum and is drawn against it by turn buckles *O.* The V-shaped upper end of the apron forms a hopper into which the fiber falls from the screen. When the drum is rotated the shrub is drawn between the belts with a rubbing and rolling motion. The particles of rubber unite and emerge at the lower end of the apron *N* in worm-like rolls. The fiber also leaves the drum at this point and falls with the rubber upon a conveyor and strainer *P* and is washed away by the sprinkler *Q,* while the rubber is carried along and deposited in the washing tank *R.*

The Lawrence Guayule Washer.

Guayule shrub is soaked in water for several hours and then cut into small pieces. These are mixed with about ten times their weight

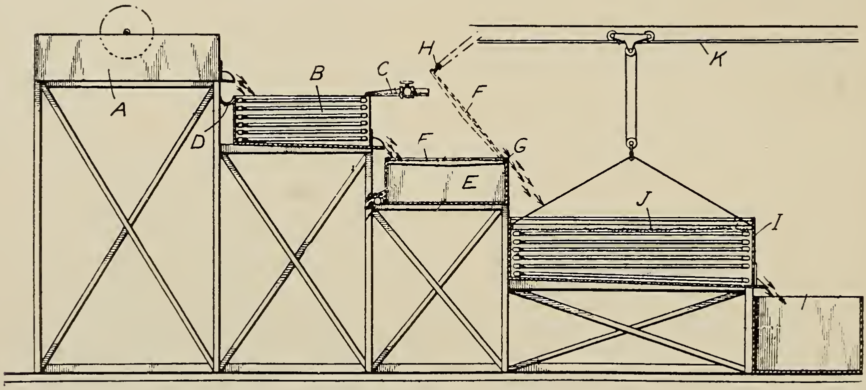


Fig. 265.—The Lawrence Guayule Washer.

of water and the mixture placed in the beater tank *A.* (See Fig. 265.) From the beater the rubber is run off into the tank *B,* where it remains suspended in the water. The light bark rises to the surface and the wood pulp settles to the bottom. The tank has steam coils, and by raising the temperature of the water its specific gravity is so changed that the rubber settles toward the bottom. The floating waste matter is blown by an air nozzle *C* into the trough *D,* which conducts it away.

The rubber and water, with the heavier refuse, is then drained off into the tank *E,* where the rubber rests on a screen *F,* hinged at *G.* The water drains into the tank and the screen is lifted by the pulley *H,* discharging the rubber and wood particles into the tank *I* containing water at a normal temperature. The fiber sinks to the bottom and the rubber remains suspended in the water. Common salt is then thrown into the tank to increase the specific gravity of the water, causing the rubber to rise to the surface, where it is carried away on a swinging screen *J* suspended from an overhead track *K.* The tank *I* is provided with coils which are connected with steam and cold water supply for regulating the temperature.

THE LAWRENCE EXTRACTOR.—*(By Solvents.)*

Fig. 266 shows an apparatus for extracting Guayule by solvents. The shrub is first crushed and placed in a basket-like cage *A* which

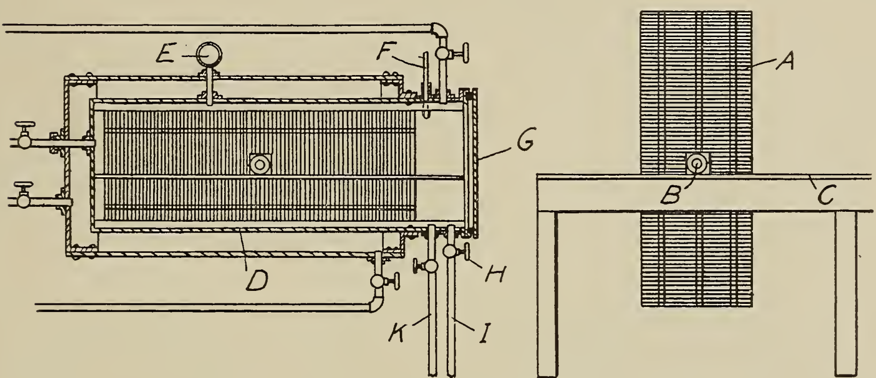


FIG. 266.—THE LAWRENCE EXTRACTOR. (BY SOLVENTS).

rests upon trunnions *B* supported on the track *C.* This has a pressure gage *E,* thermometer *F* and inlet and outlet steam pipes. After the cage is filled it is tilted horizontally and pushed into the steam jacketed cylinder *D.* The door *G* is then closed and the valve *H* opened and naphtha is forced into the drum *D* by a pump *J.* (See Fig. 267.) The valve *H* is then closed and steam admitted to the jacket. The extractor is kept at 60 pounds pressure for four hours, then the solution is drawn through the pipe *K* into a steam jacketed evaporator *L.* The naphtha vapor is condensed in the coil *M* and flows into a supply tank *N,* to be pumped again into the cylinder *D.*

The bulk of the naphtha, or other solvent used, is driven off by the heat of the evaporator *L* until the solution begins to thicken. Then

the discharge valve O is opened and the solution passes into the steam jacketed tank P containing a hot alkaline solution, which is admitted through the pipe Q. This separates the resin and naphtha from the rubber, which floats as the solution cools. This is hastened

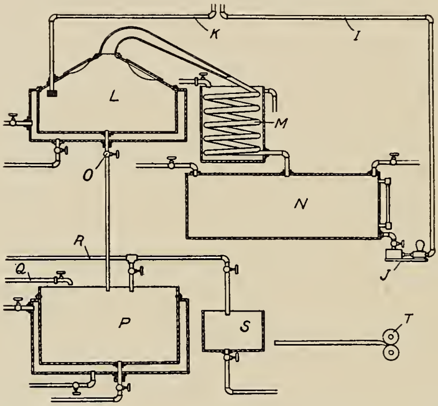


FIG. 267.—THE LAWRENCE EXTRACTOR. (BY SOLVENTS).

by the introduction of cold water through the pipe R, after which the rubber is skimmed off and subjected to repeated washings with hot and cold water in the tank S. Under this treatment it assumes a dough-like consistency so that it is easily rolled into sheets between the rolls T.

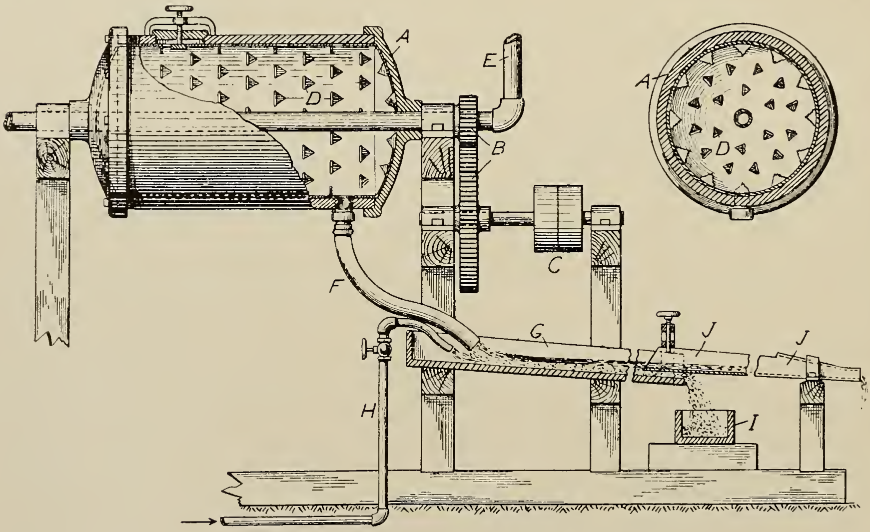


FIG. 268.—THE EPHRAIM GUAYULE SEPARATOR.

The Ephraim Guayule Separator.

The process illustrated in Fig. 268 consists in passing the Guayule shrub through a rotating cylinder with internal teeth which tear it to pieces. The second step is the separation of the rubber from the ground material by washing and finally skimming off the floating rubber.

The shrub is placed in the drum *A*, which is rotated by the belt pulley *C* and the gears *B*. The internal surface of the drum is studded with triangular teeth *D*, which tear the shrub as the drum revolves and at the same time steam is admitted to the drum through the pipe *E*. When the mass is finely divided it is discharged through the hose *F* into the open trough *G*. Water is admitted to the trough through the pipe *H* and the heavier particles sink to the bottom and fall into the trough *I*, while the rubber, which floats on the surface, is skimmed off into an adjustable sluice-way *J*.

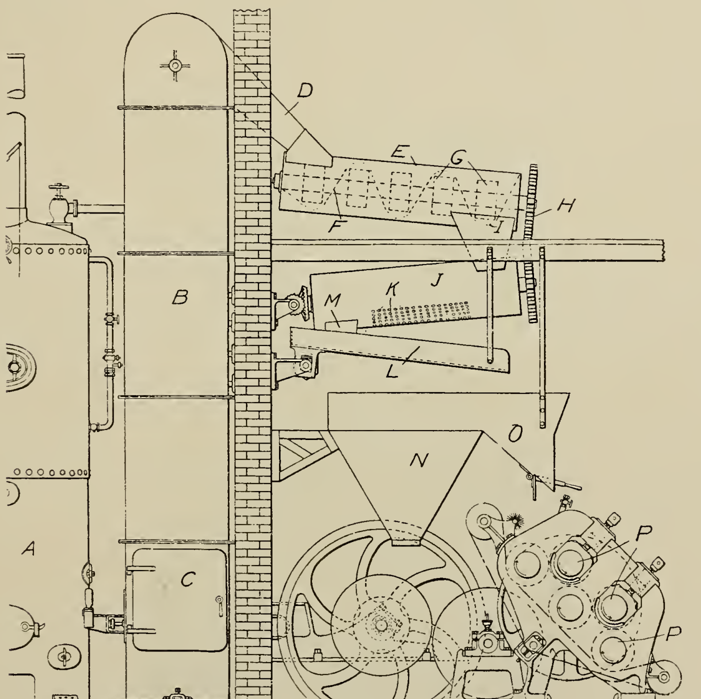


Fig. 259.—The Bridge Crusher and Extractor.

The Bridge Crusher and Extractor.

Fig. 269 shows an apparatus for crushing shrubs, vines and roots and for separating the rubber from the bark and wood. In this *A* represents a steam boiler, while *B* is a casing containing a vertical bucket conveyor which receives the shrub through the door *C*. The charge is raised to the top and conveyed through a chute *D* into a circular casing *E*. This contains a spiral conveyor *F* and several pairs of rollers *G* which crush the shrub as it passes through the casing. The conveyor and rollers are driven by the gear *H*. When the material reaches the opposite end of the casing it falls through the hopper *I* into a second casing *J*, which is similar to the first, in that it contains a spiral feeder and crushing rollers. During the passage of the crushed shrub, a part of the finely divided bark and wood falls through the holes *K* into a shaking sieve *L*, while the coarser particles pass through hopper *M*. The bark and wood fall into the dust hopper *N*, while the rubber, which coheres in larger pieces, passes through the hopper *O* and between the crushing and washing rollers *P*, which further separate the rubber from foreign matter. An endless band conveys the material back to the top of the rollers or to a discharge bin.

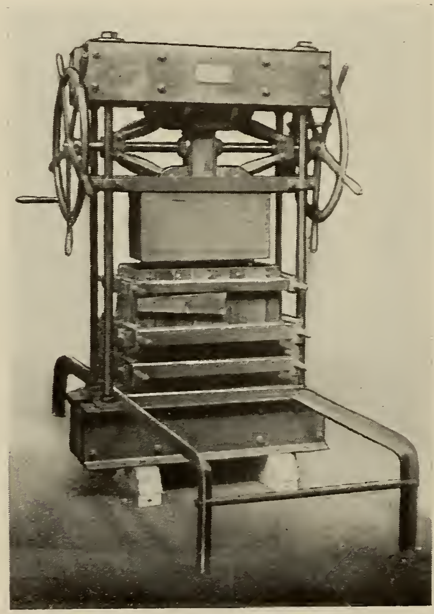


Fig. 270.—Guayule Blocking Press.

Guayule Blocking Press.

The press illustrated in Fig. 270 is an ordinary toggle joint press equipped with a collapsible frame for forming wet rubber into blocks. The frame is shown closed and filled and ready to be pressed. This is practically the same type of press that is used all over the world for blocking plantation rubber—often a screw and sometimes a hydraulic press. This particular toggle joint press makes a block 23¾ x 9¾ x 6. The forming box is lined with loose steel plates to keep the gum from sticking.

The Palmer Landolphia Decorticator.

In Fig. 271, *A* is the frame in which are journaled fourteen corrugated rollers *B*. Each roller carries a worm gear *C* and engages a worm shaft *D*, belt driven from the main shaft *G*, and all rotate

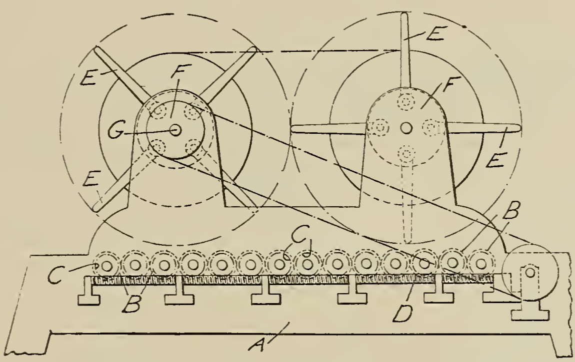


Fig. 271.—The Palmer Landolphia Decorticator.

simultaneously in the same direction. Two shafts, *G* and *F*, journaled in the upper part of the frame, are driven in the same direction. Each shaft supports four rows of steel rods *E*, which are pivoted in the shaft hubs and have their outer ends grooved. When the shafts are rotated the centrifugal force keeps the rods extended. The vines are fed into the machine by the revolving bed rollers and the rapidly revolving rods act as hammers and separate the rubber and fiber.

The Guiguet Crusher and Extractor.

Fig. 272 shows a front elevation of this machine. The engine *M* drives the crusher *B* and the agglomerators *E*, *F* and *J*. These are coned-shaped and ribbed and revolve in steam jacketed ribbed sleeves. The vine or shrub is fed through a hopper *A* into the crusher. Here it is shredded and treated with water. It then passes through

a channel C and a two-way funnel D, into the agglomerators E and F. Most of the wood particles are washed away by a stream of water while the rubber forms in masses. On leaving the agglomerators E and F the rubber passes into a trough I, which conducts it into a rotating screened drum (not shown), where more of the wood particles are

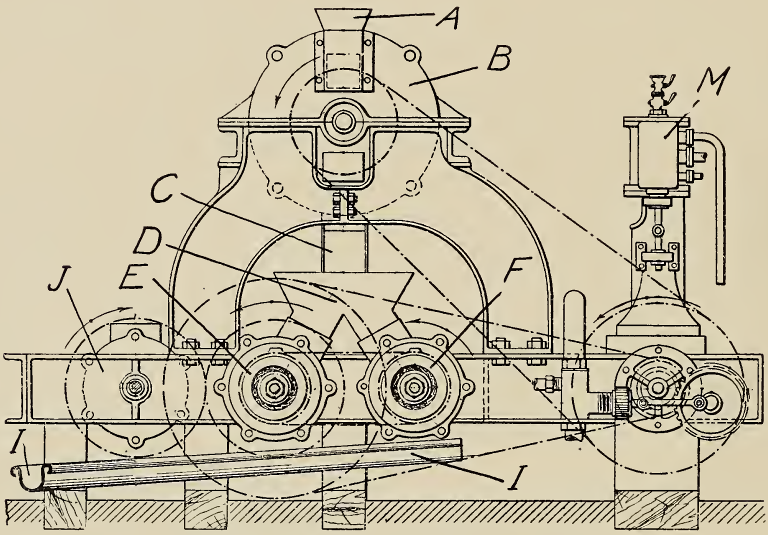


Fig. 272.—The Guiguet Crusher and Extractor.

washed away, while the rubber remains on the screen. It is then passed through the final agglomerator J, where the rubber is formed into shape convenient for handling.

The Valour Extractor.

In Fig. 273 is shown an end elevation of this machine, which is but a modified form of a tumbling barrel. The drum A is mounted in side frames B and driven by a belt pulley. The body of the drum is perforated and the inside has broad alternating convex and concave ribs C and D. Metal rollers E of small diameter and about the same length as the drum are loosely placed on the inside at the bottom. The shrub is fed to the machine through doors on the side or ends. Water is supplied through the hollow shaft bearings. When the drum is slowly revolved the rollers rotate and tumble about thereby pulverizing the shrub. The fiber is carried away through the perforations by the water and the rubber remains in the drum.

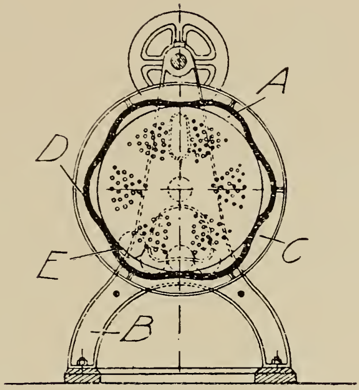


FIG. 273.—THE VALOUR EXTRACTOR.

THE KEMPTER PROCESS OF EXTRACTING RUBBER.

The apparatus shown in Fig. 274 is a German invention for extracting rubber from plants. *A* is a tank with a water inlet and outlet. Suspended in the tank is a cylindrical casing *B* with a perforated bottom *C* and a hopper-shaped top *D*. The shaft *E* is journaled in bearings (not shown) and support radial arms *F*. These are as

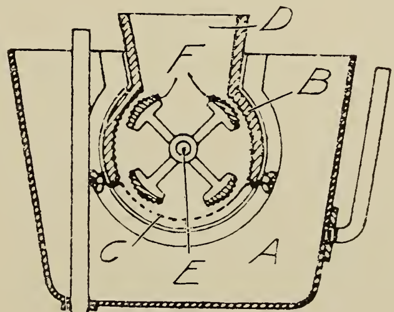


FIG. 274.—THE KEMPTER PROCESS OF EXTRACTING RUBBER.

long as the casing and have corrugated rubbing surfaces that conform to similar roughened surfaces of the casing *D*. The tank is filled with water and the plants are fed into the hopper. The revolving roll carries the leaves or plants between the roughened surfaces, which reduces them, the fine woody particles are washed out through the screen while the rubber rises to the surface of the water.

The Rigole Gutta Percha Extractor.

A French apparatus for extracting gutta percha from leaves, bark or twigs is shown in Fig. 275. The leaves or twigs are first pounded and then placed in an exhausting vessel *A*. Carbon bisulphide is placed in a water boiler *B* and passes through a tube *C*, as a vapor, into the condenser *D*. Here it is condensed and percolates through the leaves and twigs. The liquid then returns to the water boiler *B* through the tube *E*, the strainer *G* and the automatic valve *F*. After the solvent has dissolved and transferred a portion of the gutta to the water boiler, it again passes through the tube *C* and is condensed in the

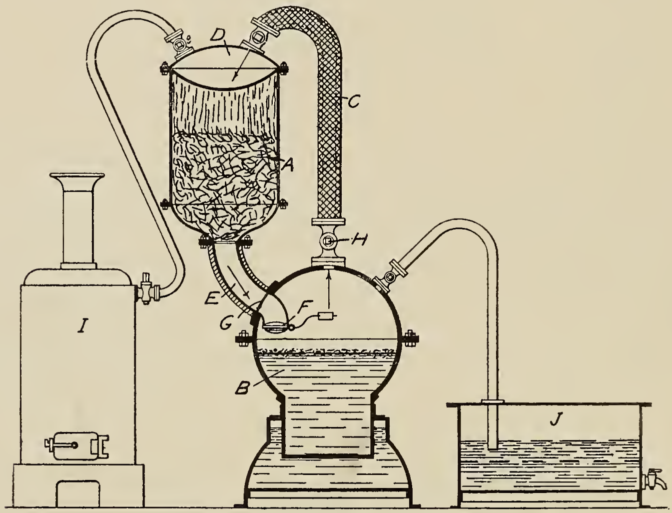


Fig. 275.—The Rigole Gutta Percha Extractor.

vessel *A* to dissolve more gum. When all the gum is dissolved and carried into the boiler, the valve *H* is closed. A jet of steam is then introduced from the steam boiler *I* through the vessel *A* and the boiler *B*. This carries away the excess carbon bisulphide into a tank *J*, while the extracted gutta percha remains in the boiler *B*.

The Serullas Gutta Percha Extractor.

Referring to Fig. 276, the pulverized gutta percha leaves and branches are placed on a filter *F* in the jacketed digester *A* which is then closed. The solvent toluene passes from a refrigerator *C* to a steam jacketed reservoir *B*. Here it is heated and then passed into the digester A, where it is mixed with the material by an agitator D. After sufficient time has elapsed the solution is discharged into the

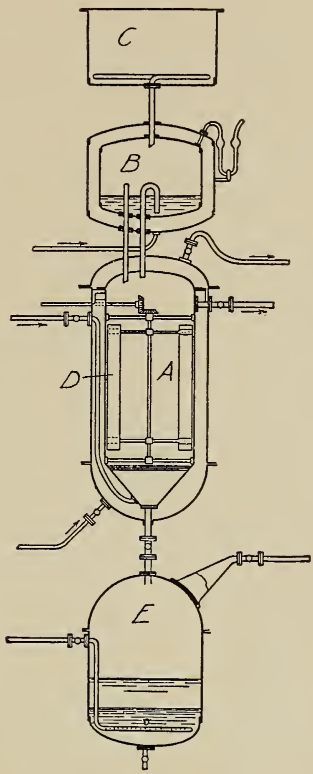


Fig. 276.—The Serullas Gutta Percha Extractor.

still *E*, where the solvent is driven off by distillation. The gutta percha is then sheeted and dried.

The Obach Gutta Percha Extractor.

This process is based on the fact that gutta percha is soluble in light petroleum spirit at the boiling temperature, but is re-precipitated on cooling below 60° F.

Referring to Fig. 277, the crushed and dried leaves are placed in a wire basket and lowered into the steam jacketed digester *A*. It is then filled with naphtha from tank *B* or *F*, and heated to the boiling point while the vapors are condensed in *C*. The solution in *A* is allowed to cool and is then drawn off into a tank *D*, fresh naphtha being admitted and the operation repeated. After draining, the remaining solvent is distilled through *C* into tank *E*, and the exhausted leaves removed. The gutta solution is then pumped into tank *B* and from

there it flows through a fresh charge of leaves or the gutta is cooled down in one of the digesters and precipitated. The mother liquor is then drawn off into tank *D*, the precipitate washed with clean naphtha from tank *F* and allowed to drain. Steam is now admitted to the digester to distill off the remaining naphtha, and the gutta which is found floating on the condensed water removed and washed. The digesters *A* and *G* are worked alternately.

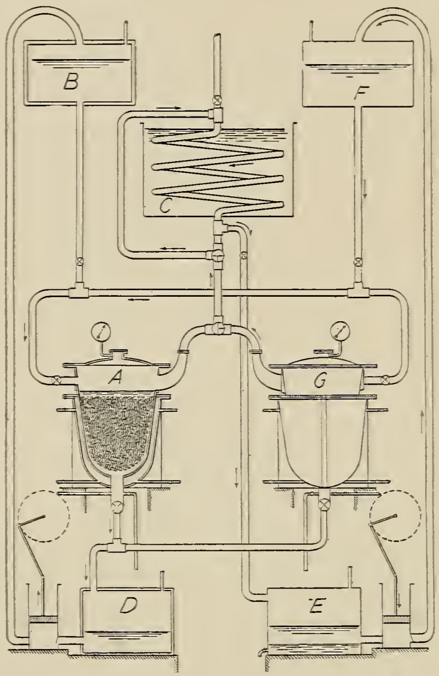


FIG. 277.—THE OBACH GUTTA PERCHA EXTRACTOR.

CHAPTER XVI.

EXTRACTION OF RESINS FROM RUBBER AND GUTTA PERCHA.

NEARLY all wild crude rubber contains resin, some having more resin than rubber. The amount of resin found in rubber ranges from 1.2 per cent. in fine Para to 75 per cent. in Pontianak. In spite of the variety of soft resins found in some grades of rubber, extraction has been successfully done on a large scale.

India rubber which has undergone complete oxidation consists principally of a hard, brown, transparent substance, shellac-like, called Spiller's resin. This resin is an acid; it combines readily with soda and potash, forming soaps which are soluble in cold and hot water. Spiller described this resin many years ago. The variability in the amount of resins which may be found in the various classes of rubber is illustrated by the results of analyses made by Lyman M. Bourne.* His table covered 181 analyses of all classes of rubber, and the results of a few of the more important are given here.

Three samples of Ceylon Para fine averaged 2.5 per cent. resin and 97.5 per cent. rubber, with no shrinkage, this being the only variety without shrinkage. The average of 23 samples of Brazilian Para fine showed 96.6 per cent. rubber and 3.4 per cent. resin, with 17 per cent. shrinkage. Six samples of prime Assam, from India, showed 15.8 per cent. resin. Two samples of Borneo second and one of Borneo third showed 19.3 and 20.7 per cent. resin, respectively. Seven samples of Upper Congo gave 13.8 per cent. resin. One sample of Brazilian strips showed 28 per cent. resin. Three samples of Mexican Guayule showed 25.4 per cent. resin and 25 per cent. shrinkage, and seven samples of Pontianak showed 75 per cent. resin and 60 per cent. shrinkage.

In analyzing these samples they were dissolved in benzol and the resin was precipitated by addition of alcohol, the gum remaining in solution. Dr. Weber, in his work on the analysis of rubber, advises that samples be treated by the Soxhlet method of extraction, using acetone as a solvent of the resins while the rubber is not dissolved.

The extraction process begins with washing and drying the raw material in the ordinary way. If the resin solvents will dissolve

*See the India Rubber World, Dec. 1, 1906——page 75.

water it is cheaper to extract the water with a portion of solvent and then put on a fresh portion to extract the resin. There are two ways of dissolving out the resin. One way is first to put on a solvent for both rubber and resin, like naphtha. Then the gum is precipitated out by acetone, leaving the resin in solution.

The other method is to use a resin solvent only, such as acetone, without dissolving the rubber.

By using a rubber solvent the rubber is softened so that the resins can be easily extracted. This is done by placing the rubber and solvent in a tight cement-mixing apparatus. (See chapter on Cements and Solutions.) A simple condenser is used to condense the solvent vapor. When the rubber is sufficiently softened, the resin solvent—acetone—is let in and the stirring continued. The rubber finally masses, when the acetone containing the resin is drawn off.

Using the other method, it is necessary to thoroughly work the rubber with the solvent. In fact it must be washed with solvent just as it is customary to wash dirty rubber with water, but there must be no exposure to the air.

There are also processes for deresinating by the use of alkalies, but such processes have not been used on a commercial scale.

Almost all of the "enclosed" washers, notably the Hood washer (see Chapter I, Fig. 10) may be and are used in deresination. The machines that follow are used only for the extraction of resins from rubber.

The Chute Deresinating Apparatus.

This is shown in Fig. 278.

The five extractors, *A, B, C, D* and *E* have steam heated jackets *F* and contain rotating macerators *G*. These extractors communicate by pipes with three kettles *H, I* and *J,* which are connected with two fractional distilling columns *K* and *L,* goose necks *M* and *N,* condenser *O* and *P,* and finally with solvent tanks *Q, R* and *S*. A mixture of methyl acetate and acetone is used. There is also a condenser *T* connected directly with the tanks and a pump *U* for forcing the different materials through the pipes. With low grade, wet rubbers the operation is as follows:

The rubber is placed in tank *A* and the macerator *G* is set in motion, while steam is admitted to the jacket to hold the solvent near a boiling temperature. Dehydrating solvent from tank *B,* which has already been used to partially dry a batch of rubber, is passed into *A* through the pipe *Y*. This solvent, after extracting the greater portion of water from the rubber, is discharged into one of the kettles.

The rubber in *A* is now treated with fresh solvent, and after being thoroughly agitated with the rubber the solvent is passed into another extractor and used again. The rubber, which has been treated twice with dehydrating solvent, is now treated to extract the resin. Solvent which has been used to treat other rubber is admitted to *A* and mixed with the rubber. It is then drained off into one of the kettles *H, I* or *J,* and the rubber is treated with fresh solvent. After taking up all the resin it will hold, this solvent is discharged into another tank to be used again, and the rubber is washed and dried.

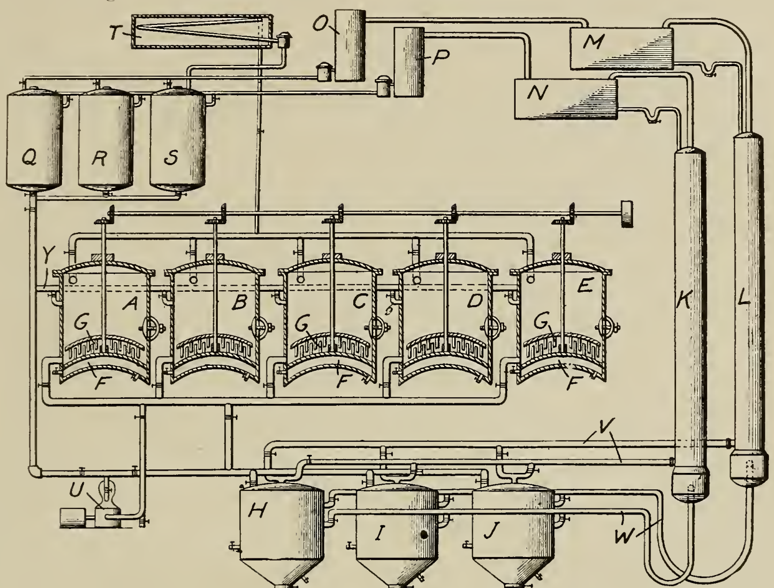


FIG. 278.—THE CHUTE DERESINATING APPARATUS.

The rubber in each extractor may be treated in the manner described for *A,* by manipulating the valves, and in practice four of the tanks are being worked with solvent and rubber while the fifth is treated with water and recharged. The columns *K* and *L* are provided for the fractionation of low and high grade solvents, each being fed by one of the vapor lines *V*. The exhausted liquid is returned to the kettles through the lines *W*. Any uncondensed vapor is condensed in *O* and *P* and finally returns to the solvent tanks to be used again.

THE EVES PROCESS.

In Fig. 279 *A* is a large, shallow tank containing a steam coil *B* and drain pipe *C*. Mounted above this tank is tank *D,* the upper end

being closed by the head *E*. The vertical shaft *F* has agitator blades *G* at its lower end and is driven by a belt pulley *H*. It is supported in the center by spider *I* which moves vertically with the shaft when it is raised and lowered. The two tanks are separated by a corrugated screen *J*. The upper tank has a door *K*, through which a perforated kettle *L* is introduced. This kettle is mounted on rollers and rests on rails *M*. In the upper end of the tank *D* is a condensing coil *N*. The operation is as follows: The shaft *F* is raised vertically and the

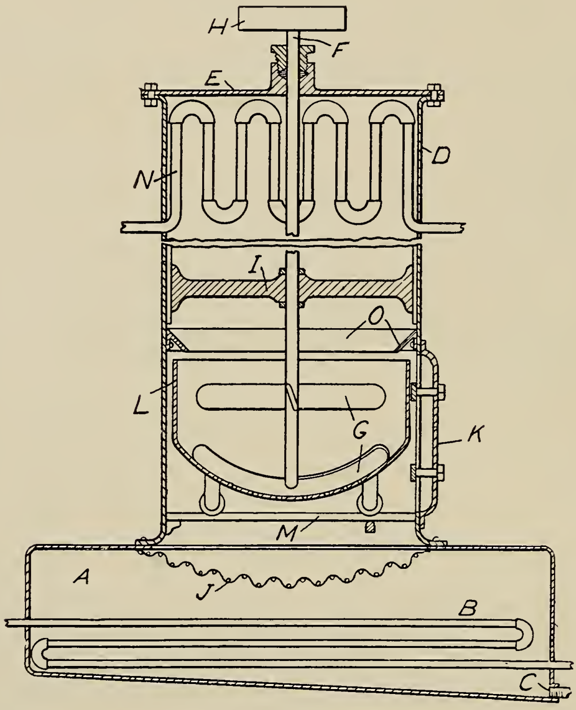


Fig. 279.—The Eves Process.

door is opened. The kettle containing the rubber is then run in the tank, the agitator shaft is lowered in place and the door closed.

The tank *A* is partly filled with alcohol which is volatilized by the heating coils. The vapor passes up between the tank *D* and the kettle *L* and is condensed by the coils *N*. The liquid then drops into the kettle, being prevented from running down the sides by the flange *O*. The agitators keep the rubber in motion so that the alcohol is thoroughly mixed with it. The resin is dissolved by the alcohol and drops

through the perforated base of the kettle and the screen *J* into the tank *A*. When all of the resin has been removed, the agitator shaft is raised, the door opened and the kettle run out for the removal of the deresinated rubber. The solution in tank *A* is drained off through the pipe *C* and is later distilled to separate the resin from the alcohol.

The Lawrence Deresinator.

The Lawrence process of refining Guayule separates the resins and also water and naphtha from the rubber. Fig. 280 shows a macerator tank *A*, an evaporator *B*, a condenser *C*, a separator *D* and a series of storage tanks, alcohol in *E*, recovered naphtha in *F*, naphthalized alcohol in *G*, and watered alcohol in *H*. Each of these receivers is provided with vapor vents, gages and inlet and outlet pipes. In tank *A* is a vertical shaft *I* bearing four horizontal rollers *J* at its lower end. This agitator is slowly driven by a belt *K* and when not in operation it is lifted out of the tank by the chain block *L*. The process is as follows:

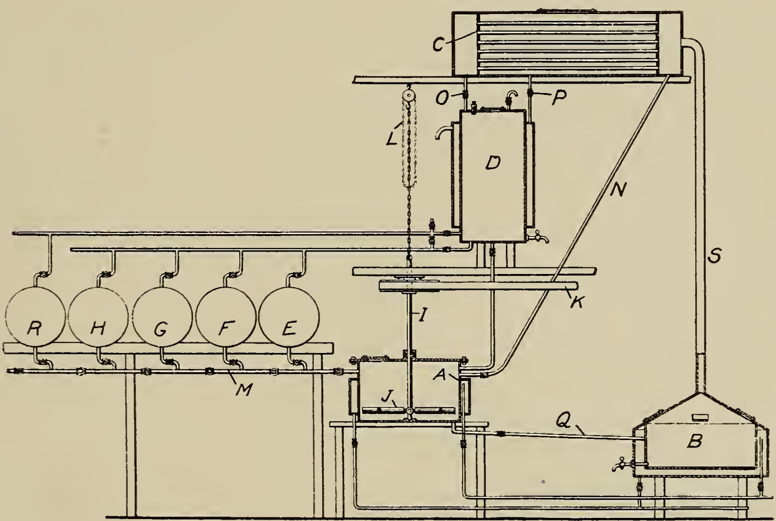


Fig. 280.—The Lawrence Deresinator.

The rubber is placed in the jacketed macerator *A* and spread evenly over the bottom. Through the pipe *M* from the tank *H* alcohol is drawn into the tank *A*. The condenser *C* is packed with ice and salt, and the valves in pipes *N*, *O* and *P* are opened. Steam is admitted to the tank *A*, heating the alcohol to about 122 degrees F. The vapor

is conducted by the pipe *N* to the condenser and is recovered in the separator *D*. The alcohol in tank *A* becomes saturated with resin and naphtha. This solution is drawn off through the pipe *Q* into the jacketed evaporator *B*, and the steam is turned on. The contents are vaporized and conducted into the condenser through the pipe *S*, the resin remaining in the tank *B*. The pipe *Q* is now closed and a second charge of alcohol is drawn into the tank *A*, when practically all of the naphtha and resin in the gum are extracted. This second charge is drawn off and evaporated as before. The deresinated rubber is removed from the tank *A* by raising the agitator and cover by the chain block *L*. Practically all the alcohol and naphtha is recovered in the separator *D*. Where rubber containing bisulphide of carbon is to be purified, a separate tank *R* is provided, on account of the disagreeable odor of this chemical.

The Lawrence Deresinator.—*(Alkali Process.)*

In Fig. 281, *A* represents a steam-jacketed kettle containing an alkaline solution, usually 10 per cent. solution of sodium hydrate.

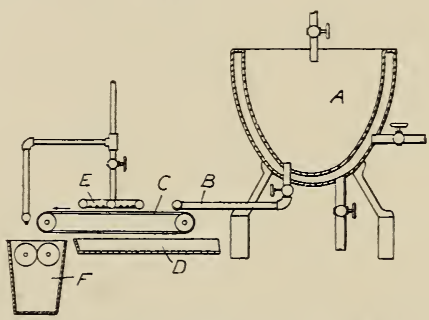


Fig. 281.—The Lawrence Deresinator (Alkali Process.)

After boiling the rubber in this solution for half an hour with constant stirring, the resin is completely dissolved and the rubber is broken up into small particles so that the contents of the kettle may be drawn off through the pipe *B* and emptied upon a moving strainer *C*. The alkaline solution, with the resin, is drained into the trough *D* while the deresinated rubber is partially washed by the sprinkler *E* and then conveyed to the washing tank *F*, where it is thoroughly cleansed and rolled into sheets.

The Flamant Continuous Process.

This is a deresinating apparatus which operates continuously, without loss of time, and renders subsequent manipulation unnecessary.

The solvent may consist of ethyl or methyl alcohol or acetone mixed with petroleum, carbon tetrachloride, benzine, ether or carbon bisulphide. Fig. 282 shows a steam jacketed still *A* for evaporating the solvent; a tank *B* for purifying the vapor and for heating the solvent; a condenser *C* and a tank *D* in which the resin is dissolved. A number of cylindrical discs of wire netting are arranged in this tank so that the solvent can circulate freely between them.

The vapors from still *A* pass through the pipe *E* into the tank *B* and through three rectifying plates *F* which dehydrate them. The vapors then pass over the coils *G*, through the pipe *H* and the con-

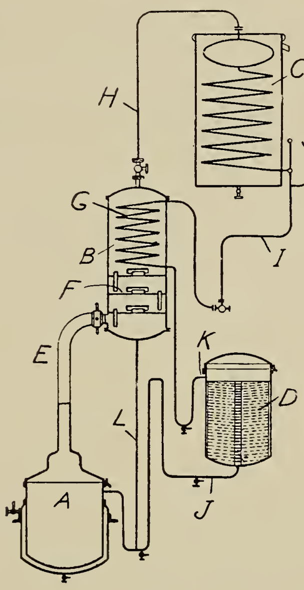


FIG. 282.—THE FLAMANT CONTINUOUS PROCESS.

denser *C*, where the vapors are condensed. The solvent then passes through the pipe *I* and the heating coils *G*, and then into the extracting tank *D*. The rubber to be deresinated is placed on the discs in this tank and subjected to the hot solvent. This removes the resin and carries it over into the still *A*, where it is deposited. The pipe *J*, through which the resin and solvent pass to the still and which is in the shape of a siphon, keeps the extractor *D* full of solvent. Vapors condensed in the tank *B* are returned directly to the still through the pipe *L*.

The Obach Gutta Percha Process.

The chemical deresinating and hardening process for gutta percha, first introduced by Obach, is shown in Fig. 283. The inner tank *A* has a perforated bottom covered with wire gauze. This tank is filled with gutta percha, which has been previously cut in pieces and thoroughly dried, and lowered into one of the tanks *B*. This is repeated until the three tanks *B* have been charged, when naphtha from tank *C* is admitted. The solution, containing a large amount of resin, is run from the last tank *B* into tank *D* and from there into still *E*, and the solvent vapor is condensed in *F*.

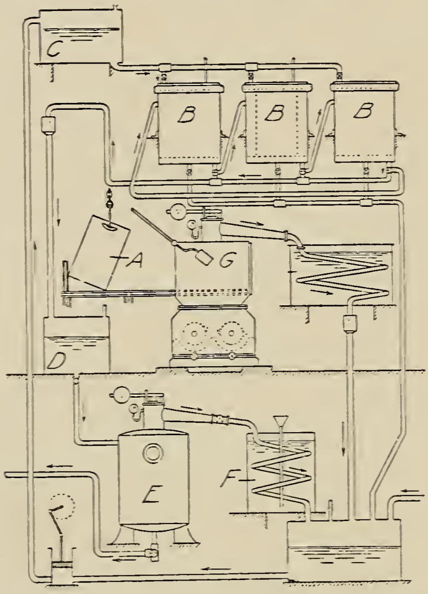


Fig. 283.—The Obach Gutta Percha Process.

The spirit from tank *A* is then run off into another tank and the gutta percha washed with clean spirit. The inner tank containing the gutta percha is lifted out and the latter discharged into the masticator *G*, previously filled with cold water. The masticator is then closed, steam is turned on and the roller set in motion to knead the gutta percha while the solvent is being distilled off and the vapors condensed. The resinous solution is distilled in *E* and the deresinated gutta percha is removed, washed, dried and sheeted.

The Haddan Resin Extractor.

In the process shown in Fig. 284, the gutta percha is treated with carbon bisulphide and filtered to remove the mechanical impurities.

The solution then passes into a series of depositing vessels, where the oxidized gutta percha separates from the non-oxidized material owing to a difference in densities. The oxidized product is deoxidized by means of carbonic oxide and the two gutta percha products are then treated with a solvent such as benzine or turpentine to extract the resin. These operations are carried out in the apparatus shown, in

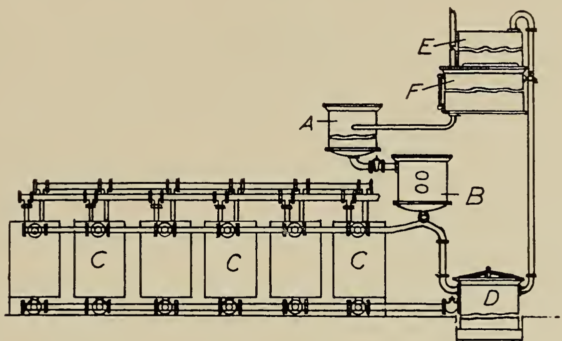


FIG. 284.—THE HADDAN RESIN EXTRACTOR.

which *A* is the receiver or mixer, *B* the filter, *C* the depositing vessels and *D* the evaporator in which the carbon bisulphide is evaporated. The vapor is condensed in the vessel *E*, containing cooling coils, and the condensed solvent is collected in the reservoir *F*. In the second series of operations, the bisulphide is replaced by benzine or other solvent to extract the resin.

THE DE LA FRESNAYE DERESINATOR.

In Fig. 285 is shown a French apparatus for extracting resin from gutta percha. *A* is a steam heated tank, connected with a naphtha tank *B* by the pipe *C*. The lower end of tank *A* communicates with the collector *D* by the pipe *E*. The collector *D* is connected with still *F* which communicates by a pipe G with the reservoir *B*. At its upper end the still is connected to the tank *A* by the pipe *H*.

The crushed gutta percha is placed in the tank *A* and covered with naphtha and the temperature gradually raised about 35 degrees C. As long as the solvent remains colorless only resin is being dissolved, but any discoloration of the solvent indicates that the gutta percha is also beginning to dissolve. Before this occurs the solvent containing the resin is run off into the tank *D*, while the gutta percha remains in the tank *A*. The solvent is recovered by distillation and the resin collects in the tank *D*. The solvent remaining with the gutta percha

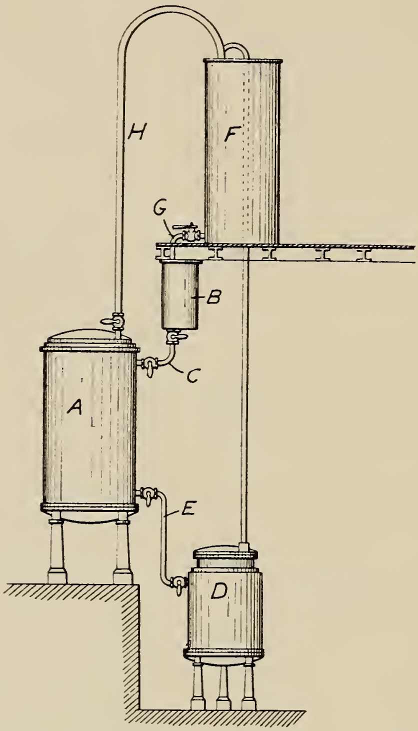


Fig. 285.—The De La Fresnaye Deresinator.

is recovered through the pipe *H* in the still *F*, from which it returns with that already recovered from the collector through the pipe *G* into the reservoir *B* to be used again.

A French Process.

The rubber is first treated with carbon bisulphide, benzine, or carbon tetrachloride and afterwards with a substance for dissolving the resins such as methyl alcohol or acetone. In Fig. 286, *C* is a steam jacketed masticator, *B B* are two revolving blade shafts. *D* contains the rubber solvent. *E* contains the resin solvent. *F* is a vacuum pump. *G* is a steam jacketed evaporator. *H* is a condenser.

The rubber is first agitated in the masticator with a quantity of the rubber solvent, then with the resin solvent. The solvent containing the resins is then collected in *G* by decantation—tipping the masticator *C* on its support. This is repeated several times to secure complete extraction of the resins. The vacuum pump is used for extracting

the remaining solvents in the masticator. The liquid solvents are separated in the evaporator and the vapors recovered in the condenser

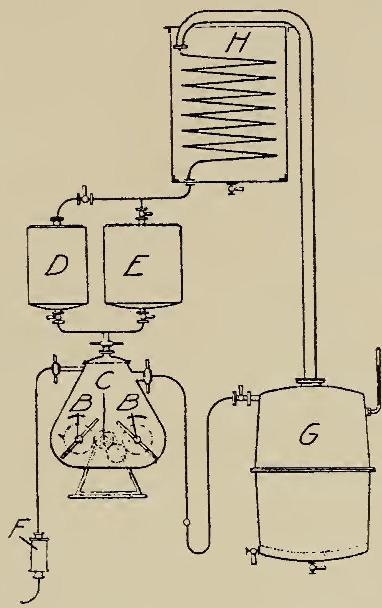


FIG. 286.—A FRENCH PROCESS.

and returned to their respective reservoirs. The purified rubber is collected in the masticator, while the resins remain in the evaporator.

A GERMAN DERESINATOR.

The apparatus shown in Fig. 287 is for extracting resins from low grade rubber such as Pontianak. It is a double apparatus, having

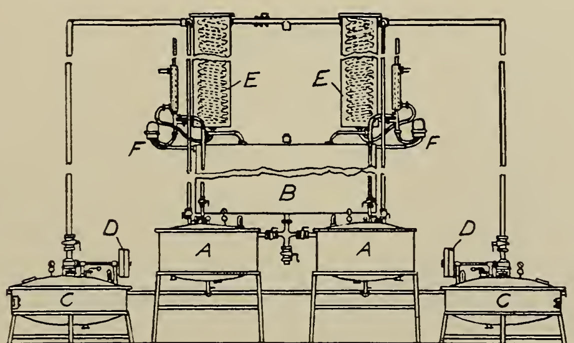


FIG. 287.—A GERMAN DERESINATOR.

two steam jacketed extractors *A*, two steam jacketed stills *C*, two condensers *E* and a solvent tank *B*.

The rubber is first dried and formed into long rolls, which are placed on perforated trays in the extractors *A*. After they are closed the rubber is covered with solvent from tank *B* and heated. The solvent, which has become saturated with resin, is then run into the heated stills *C*, where it is agitated by stirring blades operated by belt pulleys *D*. The solvent vapor passes into the condensers *E* and returns in liquid form to the reservoir *B*, by way of the siphons *F*. The rubber in the extractors *A* is again subjected to the action of the solvent and the latter is run into the stills to be again evaporated, condensed and returned to the reservoir. The process is repeated until all of the resin has been removed from the rubber. The latter is then washed and dried. Either one or both sets of apparatus shown in the drawing may be employed.

CHAPTER XVII.

RECLAIMING.

THE reclaiming of rubber from vulcanized waste has made remarkable progress within the past two decades. The improvement in processes has been marked, the extent of the business has developed wonderfully and the use of the product has increased more rapidly than the consumption of crude rubber itself.

The reclaiming of waste rubber can be divided into three groups—the mechanical, the acid and the alkali processes. In the first, or mechanical, the waste is first ground to a fine powder, and if fabric is present it is blown or sieved out by the use of compressed air or screens. If metal is present it is removed by magnetic separators. The rubber is then devulcanized, after which it can be sheeted or batched. Next is what is known as the acid process. In this the rubber containing fabric is first shredded on a cracker and is put in a tank containing sulphuric acid and water. The stock is then boiled long enough to char the fabric, after which the rubber is washed in clean water to free it from the surplus acid. It is then dried and run through a magnetic separator to remove particles of iron. Some manufacturers run it through what is known as a riffler—a long trough containing obstructions through which a stream of water is running. The riffles retain the sand and metallic particles which the magnet does not remove. It is devulcanized, then sheeted or run through a refiner, or through a strainer similar to a tubing machine. In the third, or alkali process, the rubber and attached fabric are subjected to treatment with caustic soda and water. After devulcanization, the rubber is washed to free it from the alkali, dried, sheeted and refined in the same way as in the acid process.

The Sullivan Baling Press.

Baling presses are used by scrap dealers to put the waste in portable form. They are also used by rubber manufacturers who send vulcanized trimmings to the reclaimers. They are of many sorts—lever, screw, toggle and hydraulic. Fig. 288 shows one of the simplest forms. It is simply a strong wooden box, filled with scrap. A heavy plate at the top is forced down upon the mass and partly into the

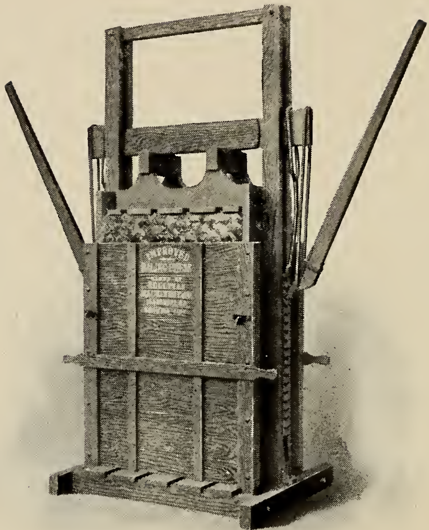


Fig. 288.—The Sullivan Baling Press.

box, compressing the contents into a bale. It is operated by two levers, one on each side, that work in ratchets.

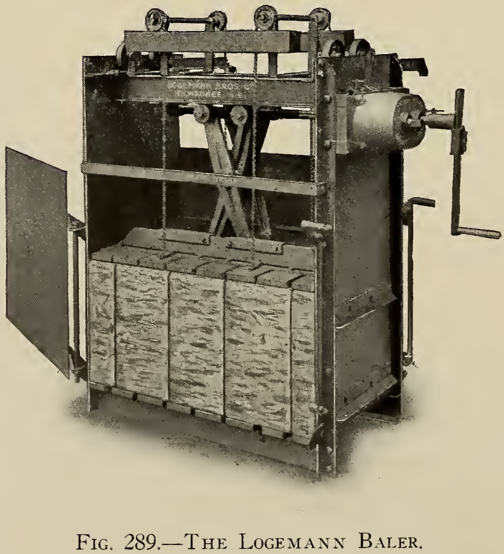


Fig. 289.—The Logemann Baler.

The Logemann Baler.

Fig. 289 shows a toggle lever baling press built of steel. It is operated by an adjustable crank and gears, which revolve the main driving screw at different speeds. Threaded on the screw are two toggle levers to which the compression plate is attached. The screw and lever construction gives a very high compression and produces a compact bale.

Alligator Shears.

When the scrap is in too large pieces to be easily handled on crackers or shredders, it is cut into pieces of convenient size by such appliances as alligator shears. Such a machine is illustrated in Fig. 290. The upper blade is pivoted and of heavy steel. The lower is

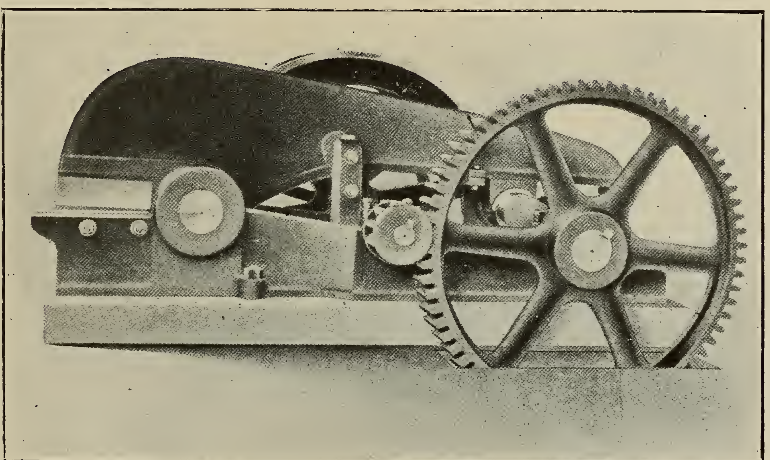


Fig. 290.—Alligator Shears.

both table and shear and is stationary. The movable blade is driven by tight and loose pulleys, with back gearing and a balance wheel. The Farrel shear, for example, is made in three sizes. One has blades 10 inches long making 40 cutting strokes a minute; another 12-inch blades making 25 strokes a minute, and the third has 15-inch blades and makes 20 cutting strokes a minute. The crank motion that opens and closes the shear is extremely simple and can be readily understood by a glance at the illustration.

The Gubbins Cutter.

Before scrap is shredded it is often necessary to remove parts that cannot be reclaimed, as, for example, the wire from wire wound

hose. Fig. 291 shows the Gubbins cutter used for this purpose. The hose is first flattened by the rollers *A* and *B*, and then slit longitudinally by the circular cutter *C*. The half sections are then grooved deeply by the cutters *D* and cut into short lengths by the cropping cutters on

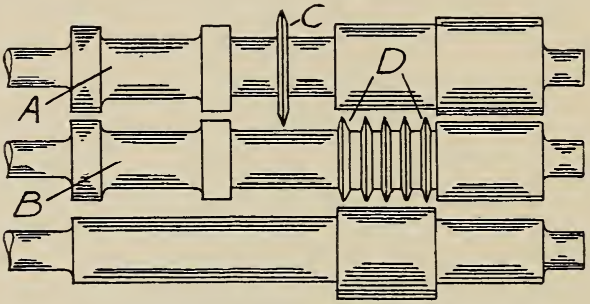


Fig. 291.—The Gubbins Cutter.

the ends of the rollers *A* and *B*. The rubber is then easily separated from the wire.

The Johnston Bead Trimmer.

Tire beads are not often reclaimed but are cut off and destroyed. The machine shown in Fig. 292 cuts off both beads of quick

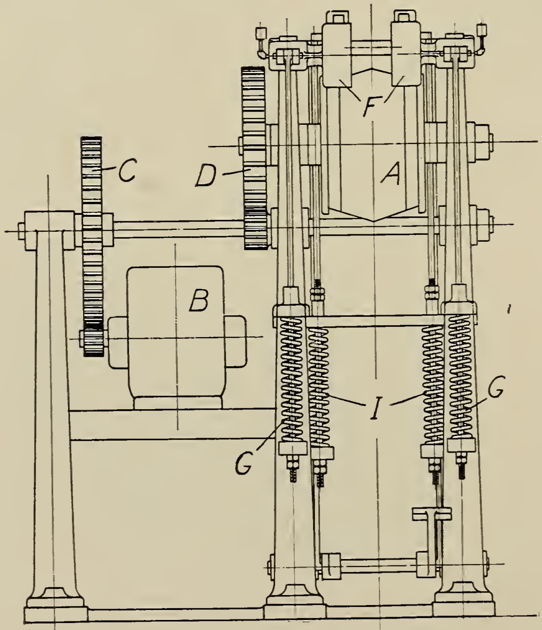


Fig. 292.—The Johnston Bead Trimmer.

detachable or clincher tires in one operation. It has a crowned roll *A* driven from the motor *B* by gears *C* and *D*. Two pressure feed rolls, covered by shields *F*, are held in contact with the roll *A* by springs *G*. Back of the feed rolls are circular knives covered by shields and held down by springs *I*. The tire is cut and one end fed into the machine under the rolls, and the circular knives sever the beads from the casing. The cutters are adjusted to cut off beads of all sizes of tires up to 6 inches. With two operators, the capacity is 25,000 pounds in ten hours.

Shredders, Grinders and Pulverizers.

Before scrap rubber can be treated for devulcanization, desulphurization or fabric removal, it is cut, shredded and powdered. An ordinary way is to use an alligator shear, a cracker and a heavy mixing mill. There are, however, a variety of cutters and pulverizers used, which are often more efficient.

The "Giant" Scrap Cutter.

Fig. 293 illustrates a machine for cutting waste into shreds. The main shaft *G* is driven by the belt pulley *H* and has mounted upon it a sprocket wheel which drives the roller *B* by a chain *I* passing over the

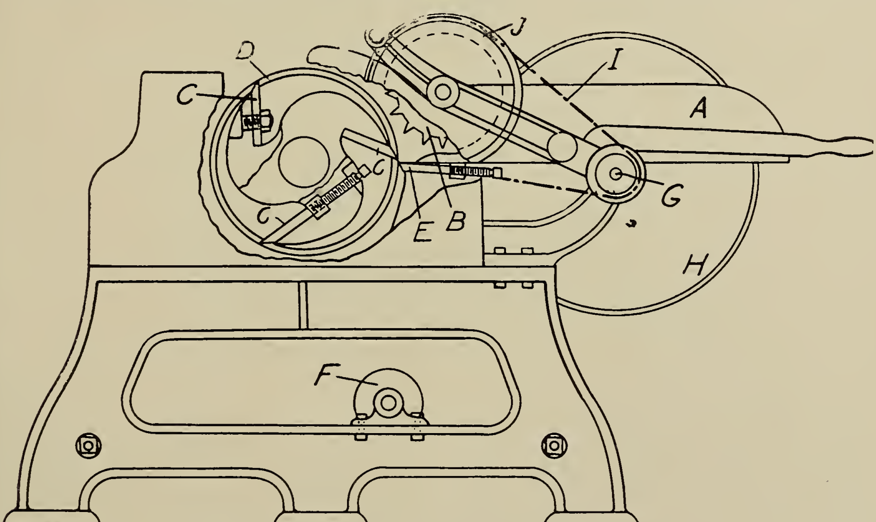


Fig. 293.—The "Giant" Scrap Cutter.

large sprocket wheel *J*. The waste is fed into the box *A* and passes under a spiked roller *B*. It is then cut by the three fly-knives *C* mounted on the revolving drum *D*, the cutting being done against the

stationary bed knife E. As the rubber is cut it falls into a receiver under the table or upon a moving apron passing over the roller F. This cutter will shred the heaviest tires. It has a capacity of 2,500 pounds per hour and requires from 10 to 12 horse power to operate at 500 R. P. M. The machine weighs 3,500 pounds and requires a floor space of 64 x 64.

Rotary Cutter.

Fig. 294 shows a rotary cutter, which has five fly knives revolving in a circular case, to the walls of which are fastened six stationary

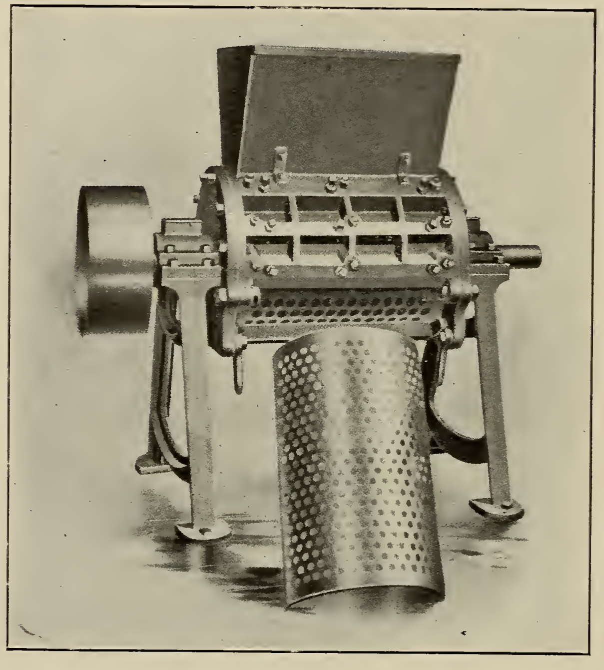


Fig. 294.—Rotary Cutter.

knives. The knives are straight, being set at an angle to insure a shearing cut, and are easily sharpened. The scrap is fed in a hopper at the top and as it is cut passes over a perforated plate which forms the bottom of the case. When fine enough it falls through a perforated plate at the bottom, otherwise it is carried around and cut again until it will pass through the perforations. The plate is removable so that another with different sized holes may be substituted. These determine the size of the product. The No. 1 machine weighs about 1,300

pounds, and requires 5 to 15 horse power at 600 to 900 R. P. M. It may be used for any kind of scrap, including hard rubber.

The Kimble Pulverizer.

The machine in Fig. 295 was designed to pulverize various spars, mica and aluminous compounds. It has been found, however, to give excellent service in reducing vulcanized scrap to a fine powder. Described briefly, it consists of two integral casings like intersecting circles with trough-like bottoms. The two shafts *B* and *C* journaled in the side-frames *A*, support beaters *D*. These are arranged spirally on each shaft. The pitch of the spiral on one shaft is different from that on the other; the beaters on one shaft passing, when in motion, through the spaces on the other. The machine is fitted with a feed and with an exhaust for removing the pulverized product.

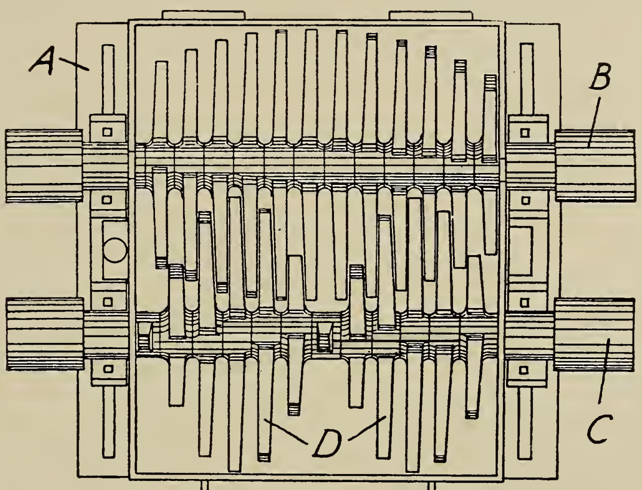


Fig. 295.—The Kimble Pulverizer.

These machines are often run in a series of three. The first takes coarse scrap, cracks it roughly and passes it on to the second; this makes a finer division, and the third further reduces the scrap and passes it to the pulverizer, which reduces it to a fine powder. It is then removed by an exhaust fan, which separates the fiber from the rubber.

The Gare Powdering Machine.

Fig. 296 shows a machine which is a rasping device for powdering vulcanized rubber scrap. The drawing on the left is a sectional view of the pulverizing mechanism, while that on the right is a front

elevation of the whole machine. It is mounted on a base consisting of a hollow casing which supports the main shaft driven by tight and loose pulleys *F*. The drum *D* is keyed to this shaft and has a rasp-like surface. The feed device consists of a spiked roller *A* and six spring rollers *B*, between which the rubber *C* is fed against the rasp-like surface of the drum. The roller *A* is rotated intermittently by

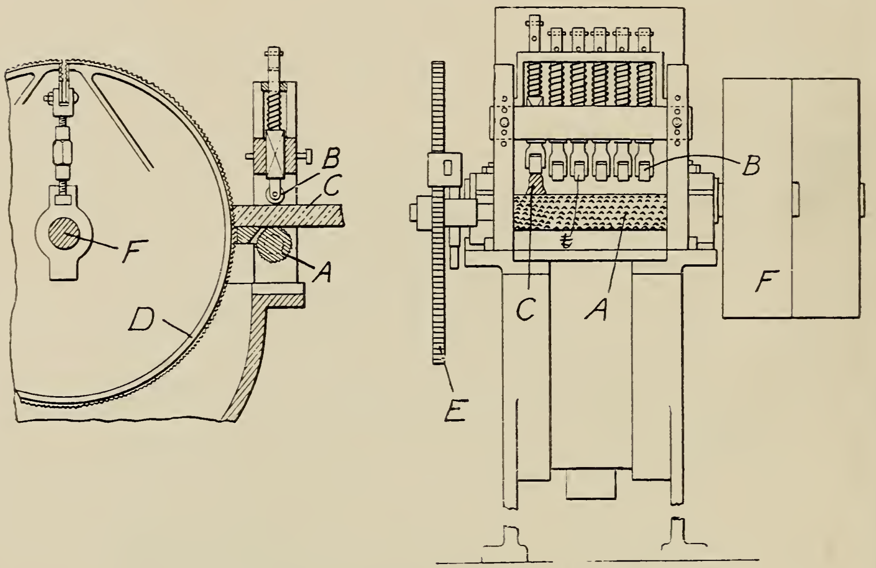


Fig. 296.—The Gare Powdering Machine.

a ratchet wheel *E*, driven by a ratchet lever and cam on the main shaft. The rubber is fed forward a short distance at each revolution of the driving shaft, and the ground rubber drops into the casing below the drum.

The Mitchell Grinding Process.

In the process illustrated in Fig. 297 three crackers are employed. The rubber scrap is cracked on the first mill (which is not shown) and conveyed by a moving apron to the second mill *A*, which has a roll *B* with fine corrugations and a roll *C* with coarse corrugations. Here, after the rubber has been further reduced, it falls on an inclined guide *D* which conducts it to the lower end of a screw conveyor *E*. This raises the rubber to an inclined screen *F*, through which the fine material falls, while the larger pieces pass between the rolls *G* and *H* of the third mill *I*. Both rolls of this mill are finely corrugated and reduce the scrap still further. The reduced rubber, both from the

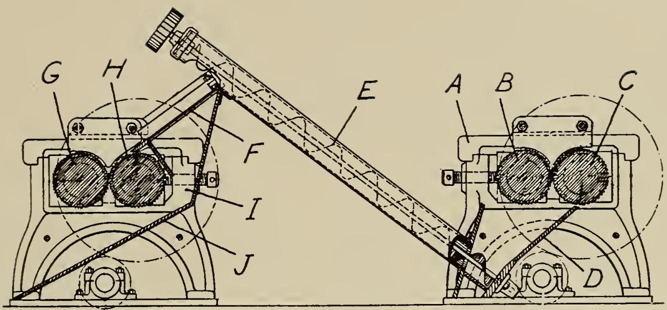


Fig. 297.—The Mitchell Grinding Process.

screen F and the mill rolls, falls upon an inclined guide J, which delivers it to a receiving bin. A rapid oscillatory motion is given to the screen F to assist in separating the fine powder from the coarse pieces.

The Gardner Disintegrator.

Fig. 298 shows a side view, partly in section, of a machine for disintegrating scrap rubber. It is mounted on a base which supports the main shaft. The abrading wheel is keyed to this shaft and is driven by a tight and loose pulley. The scrap A is placed in a sliding box B, the bottom and sides of which are perforated for ventilation.

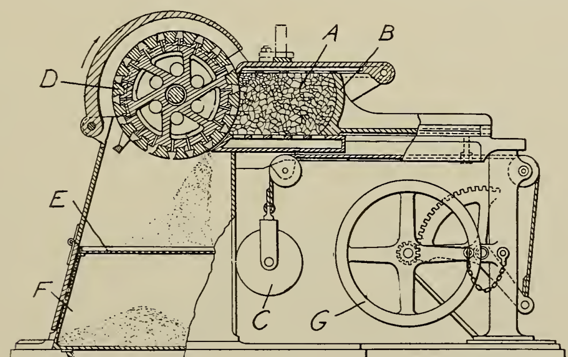


Fig. 298.—The Gardner Disintegrator.

A fan circulates a current of air through the rubber to prevent heating. The box is fed forward by a weight C, and the scrap is abraded by the rapidly revolving wheel D faced with emery or carborundum. The ground rubber falls through a screen E into a removable bin F. When the box B has reached the end of its forward travel it is pulled back for refilling by hand wheel G which raises the weight C.

The Williams Shredding Machine.

In Fig. 299 is shown a sectional elevation of a machine for shredding boots, shoes, etc. The scrap is fed into the hopper *A* and conveyed by the revolving rollers *B* to the feed rollers *C* and *D*. As the rubber passes through these rollers and over a stationary triangular

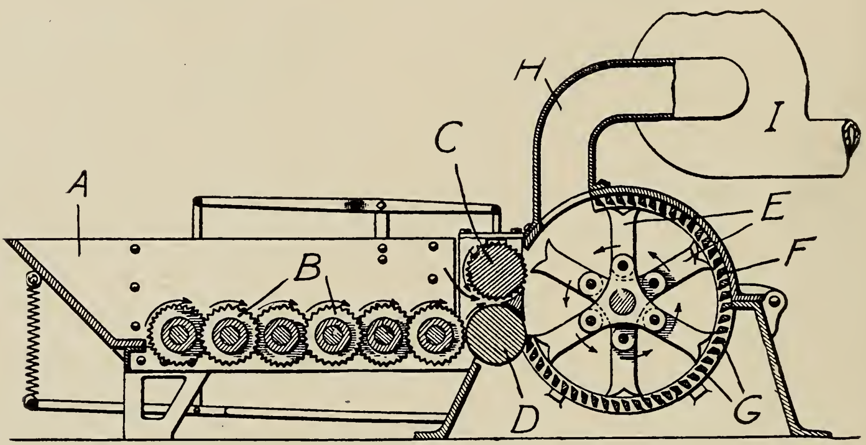


Fig. 299.—The Williams Shredding Machine.

cutting bar it is shredded by the ends of rapidly revolving hammer bars *E*. The material which will pass through the screen *G* is discharged from the machine, otherwise it will be reduced by the hammers until it passes through the screen. The particles of fabric are blown

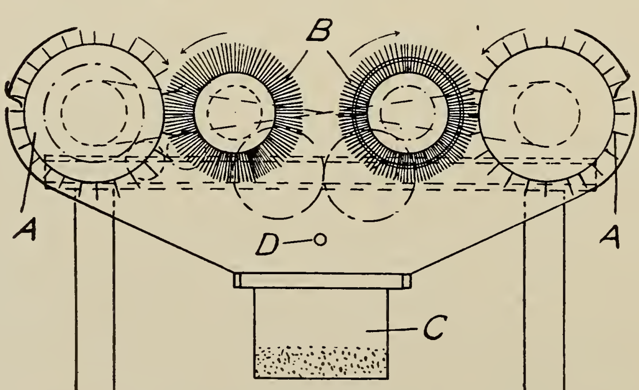


Fig. 300.—Separating Rubber and Fabric.

from the cage through a pipe *H* by an exhaust fan *I*. The feed is automatically stopped if pieces of metal or stone pass between the rollers.

Separating Rubber and Fabric.

Debauge's process consists in first treating rubberized fabric with a solvent which swells the rubber and loosens it from the fabric. Referring to Fig. 300, the treated fabric is fed into the machine from either end, between the rollers *A* and the circular brushes *B*. The brushes revolve at a higher speed than the rollers *A*, and remove the rubber from the fabric. The rubber falls in the bin *C* and the solvent vapors are drawn off through the pipe *D* for subsequent recovery.

Fiber Separators.—(*Dry.*)

Getting the fiber and foreign material out of powdered rubber is done in two ways—by dry machines and by those that use water. Both types are described below.

The Penther Separator.

Fig. 301 shows a longitudinal vertical section of a dry separator. The rubber waste is fed into a hopper at the top of the casing *A* and

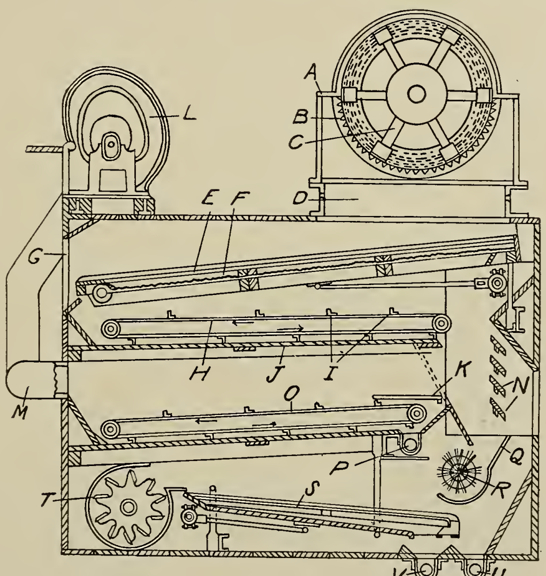


Fig. 301.—The Penther Separator.

is disintegrated in the cage *B* by the rotating arms *C*. The material falls through a grating into a chute *D* and on an oscillating sieve *E*,

the meshes of which increase in size toward the lower end. The light, fibrous material is blown upwards by a current of air forced through the pipes *F* and passes through an opening *G* out of the casing. The rubber falls through the sieve on an endless belt *H*, having cross bars *I* which travel in contact with the plate *J* and scrape the rubber off into the space *K*. As the material falls through this space, a strong current of air induced by the suction fan *L* through the pipe *M*, enters through the adjustable flaps *N*, and deposits the light material in the chamber occupied by the endless band *O*. The lighter fibers are drawn through the pipe *M* and discharged, while the rubber, coarse fibers and particles of metal are carried along by the band *O*, discharged into a screw conveyor *P*, and carried by an elevator back to the sieve *E*, where it is again subjected to the sifting and sorting process. The flaps *N* are adjusted by outside levers to regulate the current of air passing through the space *K*, according to the material to be treated. All the heavier material falls through the space *K* on a plate *Q* and is thrown by a rotating brush *R* on an oscillating sieve *S*. Here the material is subjected to a reverse air current produced by the fan *T*. The fiber is blown into a conveyor *U* while the rubber falls into a conveyor *V*.

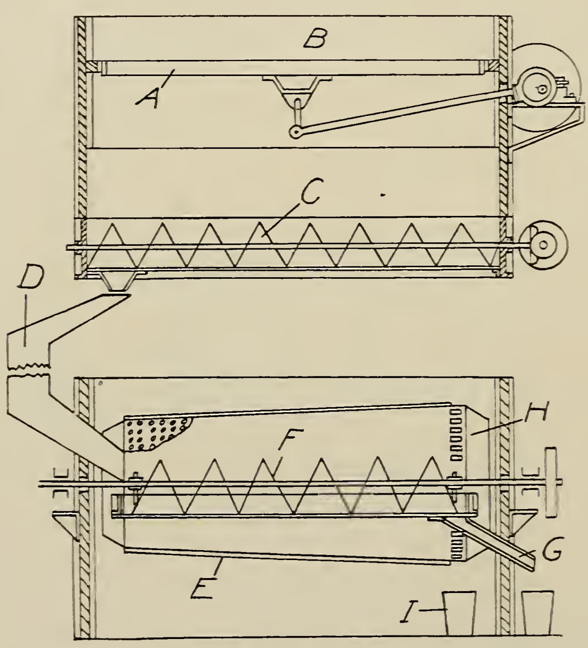


Fig. 302.—A German Separator.

A German Separator.

In the Grummel machine, Fig. 302, the material is first disintegrated and then placed on a reciprocating frame *A* mounted in a stationary frame *B*. Each of these frames has a screen made up of parallel wires. The frame *A* is oscillated by an eccentric mounted on the main shaft, and the fiber remains on the screen while the pulverized rubber falls through wires and is conveyed by *C* through chute *D* into a rotating drum *E*. This drum is conical and perforated with holes. It has an outer covering of metal and an inner one of leather, both perforated with holes coinciding with those of the drum. When it is rotated the heavy metallic particles are thrown against the walls of the rotating drum and pass out through the perforations, or slits, while the finer rubber particles are conveyed by the screw *F* to the outlet *G*. The larger pieces of rubber not separated from the fiber pass out through the slits *H* and are caught in a receptacle *I* to undergo further treatment.

Magnetic Separators.

One of the difficult problems in rubber reclaiming is to eliminate all iron. Overshoes contain it in the form of nails, buckles, stiffeners; tires, in the form of tacks, nails, and bits of wire that have been

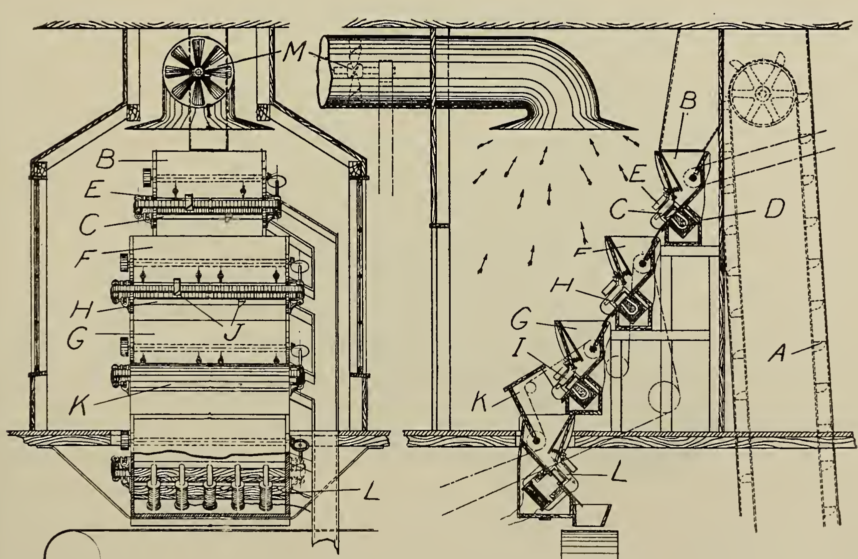


Fig. 303.—The Mitchell Separator.

picked up on the road, and so on. For chemical as well as mechanical reasons, every particle of this iron must be eliminated, in order to make the reclaimed material of any value.

The Mitchell Separator.

This machine is illustrated in Fig. 303. The drawing on the left is a front elevation, and on the right is a side view. The rubber is first pulverized and delivered by a conveyor *A* to a hopper *B*, falling by gravity across a plate *C* behind which are a number of permanent magnets *D*. Loose pieces of iron or steel are held by the magnetized plate until removed by the scraping mechanism *E*. The same process is repeated successively in the hoppers *F* and *G*. Pieces of metal not removed by the first are held by the second magnetic plate *H* or the third plate *I*. These are also equipped with scrapers *J*. The rubber finally falls into a hopper *K* where the remaining iron or steel particles are held by the electro-magnet plate *L*. During the process a gentle exhaust is maintained by the fan *M*, which removes the dust from the rubber as it falls from one hopper to the next.

The Eureka Separator.

In this machine, Fig. 304, the pulverized rubber is run into a hopper. There a spiked feed roller keeps the rubber stirred up. Under

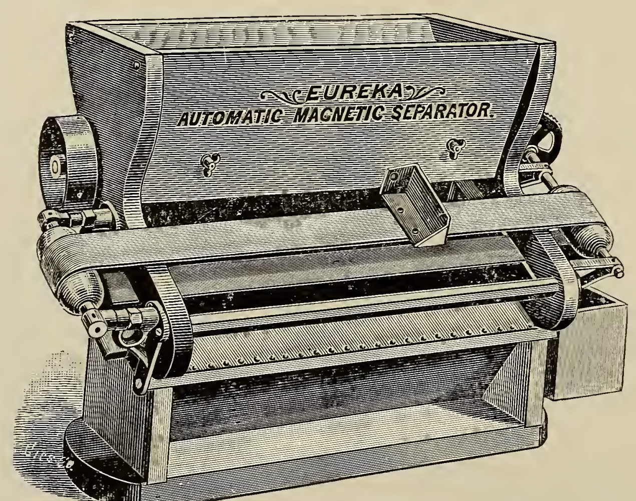


Fig. 304.—The Eureka Separator.

this roller is a corrugated feed roller which regulates the supply of material fed over the magnetized bed. The latter consists of a bank

of magnets laid side by side in a vertical position about $1\frac{1}{4}$ inches apart. Over the poles of the magnets is placed a "keeper," consisting of a thin plate of tungsten steel. The bed of the machine is inclined so that the rubber passes over it by gravity and the magnets hold the particles of iron or steel until removed by an automatic scraping device and deposited in a box at the end of the machine.

The Dings Separator.

Fig. 305 shows this machine, which consists of a large inclined magnetic table with a rubber belt traveling over it very slowly in an upward direction. The ground rubber is fed upon this belt from a

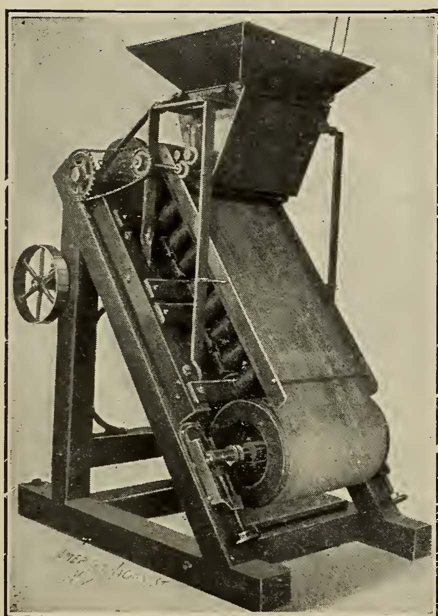


Fig. 305.—The Dings Separator.

feeding hopper. As the material rolls by gravity down the incline all particles of iron are held against the belt and carried upward over the top pulley and discharged into a box. The rubber falls from the belt and collects at the bottom of the incline.

The Geist Separator.

This is of English origin. The illustration, Fig. 306, shows the drum only, over which a feed hopper is placed. The point of interest in the Geist separator lies in the special construction of the

drum. On starting the machine an oscillating tray distributes the rubber upon a slide, which conveys it to the drum at a tangent. The drum is fitted with toothed projections which carry the material around. Inside the drum is a stationary magnet which can be adjusted at any arc of the circumference. The iron particles attracted by the

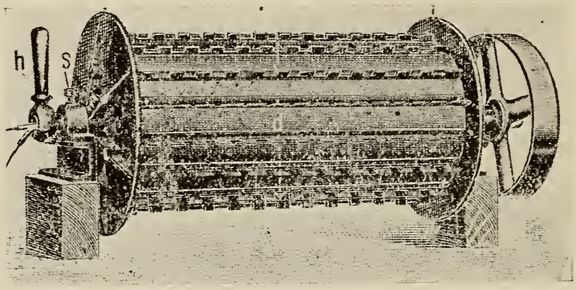


Fig. 306.—The Geist Separator.

magnet are held by the revolving drum until they are no longer under the influence of the magnet, when they fall off. The non-magnetic parts fall off in another direction.

The Mitchell Defiberizing Tanks.

The reclaiming apparatus illustrated in Fig. 307 was patented in 1881 and consists of a lead lined box *A* with perforated steam pipes

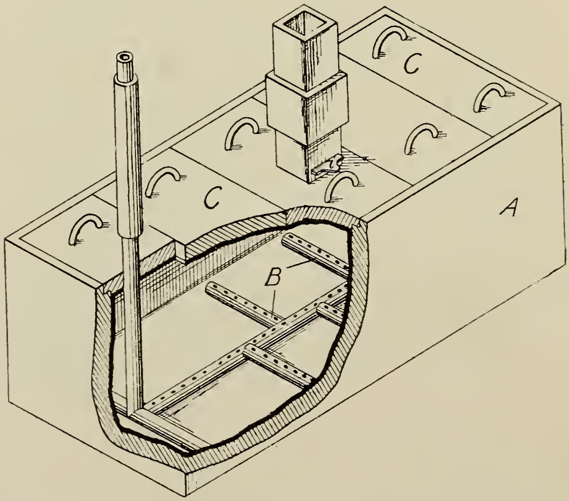


Fig. 307.—The Mitchell Defiberizing Tank.

B and removable covers *C*. By this process 60 deg. Be. sulphuric acid was added to the rubber and boiled with steam at 50 pounds pressure for about 5 hours. This dissolved the fiber but had no effect on the rubber.

This in reality was the beginning of the acid process. Today, in dissolving fiber by acids, many kinds of tubs or vessels lined with lead are used, the steam being led in through a perforated lead pipe. Wooden stirrers are used, as they can be easily replaced when worn.

The Mitchell Defiberizing Apparatus.

In Fig. 308 is illustrated the type of tank used in the largest plants. The tank *A* is lead lined and has a number of removable covers *B*, a flue *C* for the escape of vapors, and perforated steam pipes *D*. The rubber is conveyed to a hopper *E* and discharged into the

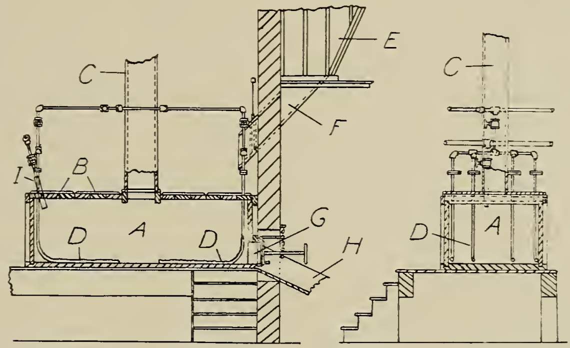


Fig. 308.—The Mitchell Defiberizing Apparatus.

tank through a chute *F*. When the process is complete the gate *G* is opened and the contents of the tank discharged through the chute *H*. The tank is then flushed out with water from the pipe *I*.

Washing Tubs and Washers.

Rubber scrap, after being defiberized, is run into a great vat known as the washing tub, where the acid or alkali is washed away. Mitchell's washing tub, illustrated in Fig. 309, is the common form of machine. It consists of a large circular vat *A*, in the center of which is a vertical shaft *B*, to which is attached a cross beam *C*, slightly above the top of the tub. Mounted on the cross beam are four vertical shafts, on the lower ends of which are plows or stirrers that can be set at any angle by a hand operated worm shaft. Directly behind the plows is a heavy conical roller *E* with wooden slats on its surface. The stock to be washed is discharged into the tub through a

chute, and the shaft *B* is set in motion. The plows are set at the desired angle, by a handle *F,* to stir up the rubber and expose every particle to the action of the heavy roller *E.* The rubber is kept covered with water through the pipe *G,* and from time to time the gates *H* are opened to draw off the dirty water. After washing,

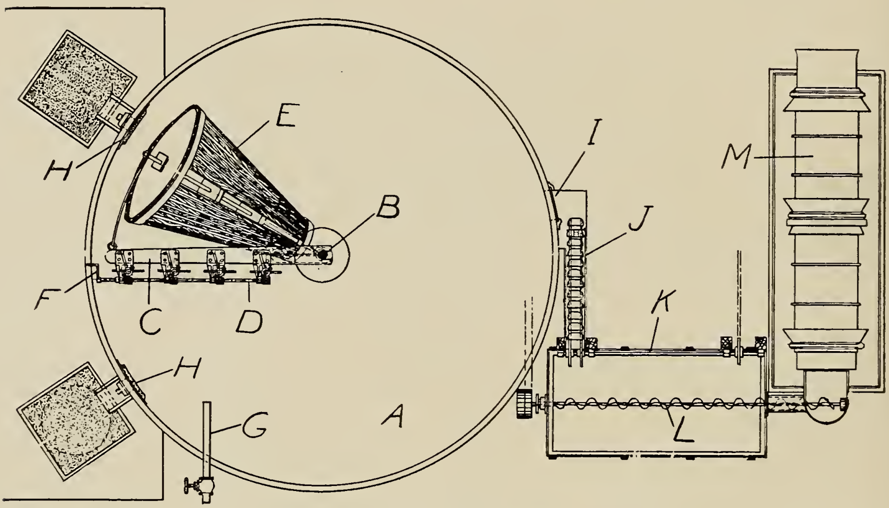


Fig. 309.—The Mitchell Washing Tub.

the plows are set obliquely to force the rubber toward the outside of the tub, and the discharge gate *I* is opened, allowing the stock to escape into a conveyor *J,* which carries it up into a trough *K* having a conveyor screw *L* in the bottom. This screw discharges the rubber into the hopper of the rotary washer *M,* which is illustrated below.

The Mitchell Rotary Washer.

Referring to Fig. 310, this washer consists of a cylinder *N,* perforated with large holes at the upper end and small ones at the discharge end. It is inclined at an angle, being higher at the feed end. Inside the cylinder are longitudinal ribs *O,* which pick up the rubber and turn it over during each revolution. Surrounding the cylinder is a tank *P,* supplied with cold water through a pipe *Q,* and hot water, when necessary, through a pipe *R.* While the rubber is passing from the upper to the lower end of the cylinder impurities are washed out through the perforations, and the rubber is discharged into an elevator *S.* The drainage is through a pipe *T,* where fine pieces of rubber which pass out are caught by the sieve shown at *U.*

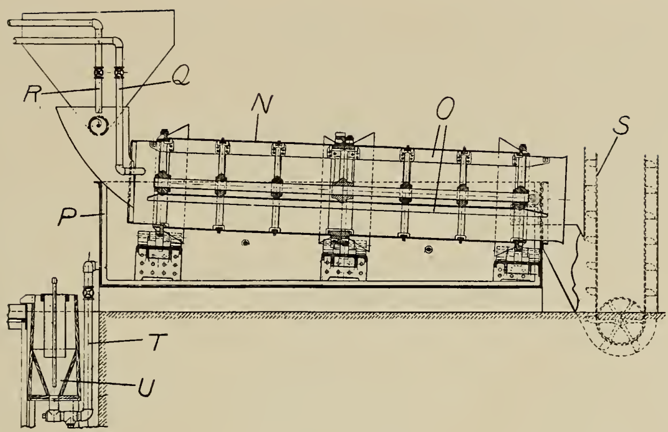


Fig. 310.—The Mitchell Rotary Washer.

The Solliday Washer.

Fig. 311 illustrates Solliday's washer. The upper drawing shows a side view of the complete apparatus, while the two lower drawings show details of parts of the machine. *A* is a long trough having an inclined chute *B* at its receiving end and a conveyor *C* at the discharge end. Within the trough are a number of paddle wheels *D* driven by an endless sprocket chain *E*, which also operates the conveyor. The trough is filled with water to the line *F*. In the bottom, between each pair of paddle wheels, is a tube *G* having a long opening *H* closed by a sliding gate *I*. The operation is as follows:

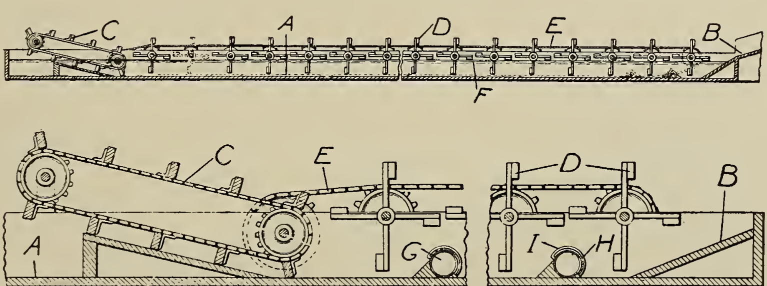


Fig. 311.—The Solliday Washer.

The stock is fed into the trough and moved along by the paddle wheels, which keep it constantly stirred. Foreign material, such as sand, settles over the tubes *G* and is removed at the side of the trough by opening the sliding gates *I*. When the waste reaches the dis-

charged end of the trough, the foreign matter has been removed and the cleansed rubber is picked up and carried out of the trough by the conveyor.

The Clark Cleaning Apparatus.

A plan view and a sectional side elevation of this machine are shown in Fig. 312. The narrow trough *A*, having at regular intervals gates or dams *B*, is set at a slight angle and is supplied with water through a pipe *C*. The ground rubber waste is fed into the machine at the upper end and passes through the several compartments and over the successive gates to the lower end of the trough, where it is delivered by a conveyor *D* over a screen *E* to a devulcanizer car, while the water passes through a screen to the sewer or a tank as desired. While the material is passing over the gates and to the screen, the refuse, such as sand, gravel or particles of metal, will settle

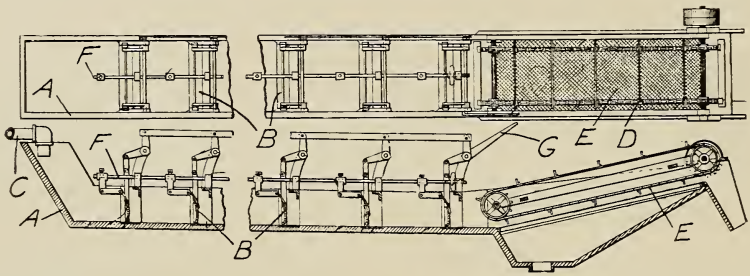


Fig. 312.—The Clark Cleaning Apparatus.

to the bottom of the compartments formed by the gates. These gates can be adjusted separately at any angle or moved all together by a hand wheel on a rod *F*. When a batch of stock has been run through the machine and it is desired to remove the refuse in the bottom of compartments, the gates can all be raised simultaneously by a lever *G*. The conveyor *D* and screen *E* are then raised, and by turning on the water the refuse is easily flushed out.

The Askam Washer-Separator.

In Fig. 313 the pulverized rubber is fed by a screw conveyor *A* into a trough *B*, which is supplied with water from a pump *C* through the pipe *D*. The rubber is partly freed of impurities and passes into the trough *E* and then into the trough *F*. In these troughs is a series of dams *G*, which retard the flow of water and rubber while the heavy matter settles. The rubber finally passes into a settling tank *H* provided with diaphragms *I* extending only part way to the bottom. Here

the light foreign matter, such as chips, cork, etc., is separated and removed. The cleansed rubber then passes through the pipe *J* and is deposited on the sieve *L*. An endless chain *K* having a series of brushes on its surface forces the fine particles of rubber through the sieve and removes the coarse. Below the sieve *L* is another chain brush *M* and

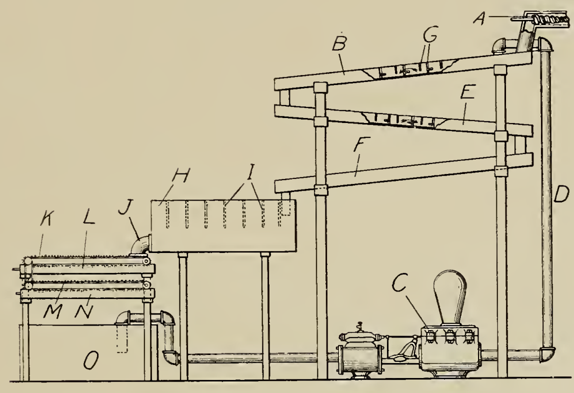


FIG. 313.—THE ASKAM WASHER-SEPARATOR.

a finer sieve *N* which also operate in the manner previously described. The water used for washing is caught in a tank *O* and, after settling, is forced by the pump *C* into the first washing trough *B*.

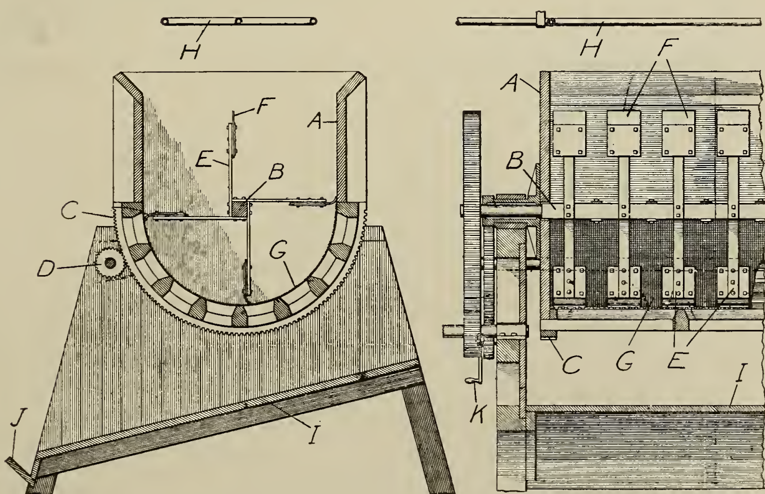


FIG. 314.—THE KONEMAN WASHER-SEPARATOR.

The Koneman Washer-Separator.

In Fig. 314 is shown an end view and a sectional side view of this machine. It has a U-shaped tank *A* swinging on a shaft *B*. Attached to the tank are circular racks *C* driven by pinions *D* for tipping it to remove the charge. Attached to *B* are a number of arms *E*, on the outer ends of which are rubber covered blades *F* which bear against the screen *G* forming the bottom of the tank. The rubber to be cleaned is placed in the tank and water turned on from the overhead pipe *H*. The shaft is set in motion and the blades keep the contents stirred up and allow foreign matter to wash through the screen. The water and refuse fall on the inclined platform *I* and are carried away through the trough *J*. After washing, the tank is tipped by the handle *K* to remove the rubber.

The Simon Separator.

Simon's machine, Fig. 315, separates the buoyant or flotable materials from the rubber and conveys them from the machine while the heavier waste, such as sand and dirt, sinks to the bottom of the tank.

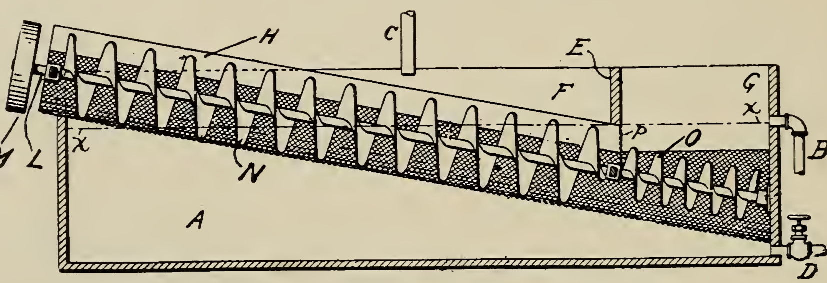


Fig. 315.—The Simon Separator.

In the accompanying drawing, which shows the machine in longitudinal section, *A* is a long tank containing water to the level *X X*. This tank has an inlet pipe *C* and drain pipes *B* and *D*. A partition *E* is located near one end of the tank, dividing it into compartments *F* and *G*. Mounted in the tank is an inclined trough *H* made of wire cloth. The trough is mounted on a shaft *L* and has a driving pulley *M* at its upper end. On the shaft are two series of helical conveyor blades *N* and *O*, separated down to the shaft by the perforated apron *P*.

During the washing operation a constant water level is maintained in both compartments. The rubber is fed into *G* and as the shaft is rotated the blades loosen the light foreign materials, which rise to the surface of the water and are prevented from passing into part *F*

by the screen *P*, while the heavier refuse drops through the perforations of the trough. The rubber is forced under the apron *P* and conveyed along the trough, the heavy particles sinking to the bottom of the tank and the lighter ones floating on the surface of the water, where they are skimmed off. As the rubber is forced along by the blades it rises from the water and passes from the trough into a suitable receptacle.

CHAPTER XVIII.

RECLAIMING (*Continued*).

CONVEYORS.

A VARIETY of belt, bucket and screw conveyors are used in carrying the stock that is being reclaimed, from one process to another. They are usually designed to suit the needs of the particular plant in which they are installed.

The Mitchell Conveyor.

Fig. 316 shows a belt conveyor *A* installed directly under the magnetic separator *B*, which was illustrated in Fig. 303, Chapter

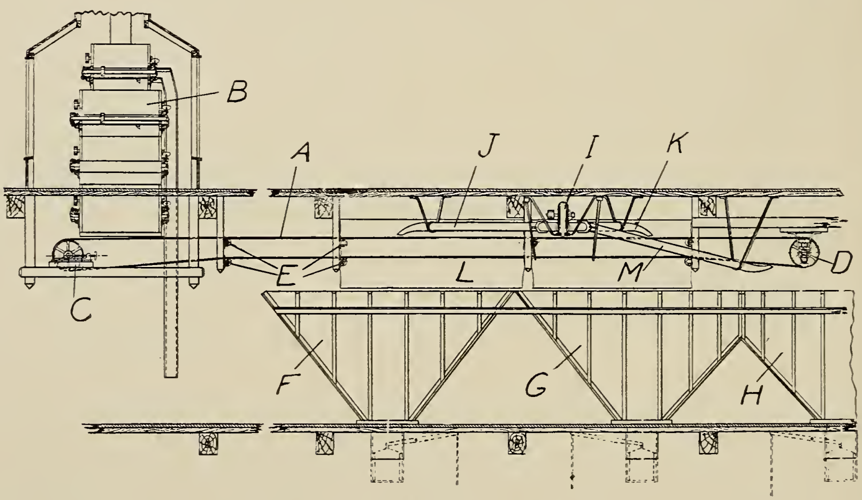


Fig. 316.—The Mitchell Conveyor.

XVII. The waste is first reduced on a cracker and fed into the magnetic separator, which discharges directly on the conveyor belt. This belt runs on pulleys *C* and *D* and is supported by rollers *E*. Beneath the conveyor, near the discharge end, are bins *F, G* and *H*. The last of these is under the end of the belt and receives the material not removed before it reaches this point by the blower *I*, attached to pipes *J* and *K*, with nozzles directly over the belt. To remove the rubber from the belt to the first bin, the pipe *K* is closed by a valve and the

fan blows the rubber from the belt against a screen L so that it falls into the bin F. The rubber is removed to the second bin G by operating the air nozzle M in the manner previously described. A third pipe M is provided for blowing the dust from the conveyor after the discharge of the material.

The Clark Conveyor.

Fig. 317 shows a plan of a system for conveying rubber waste from one apparatus through the different steps of reclaiming. The scrap is fed through a chute A to the cracker B and from it passes into a rinsing tank C. A conveyor D collects the rubber from the tank and discharges it into a second cracker E, from which it passes into a second rinsing tank F. The stock is then transferred by a conveyor G

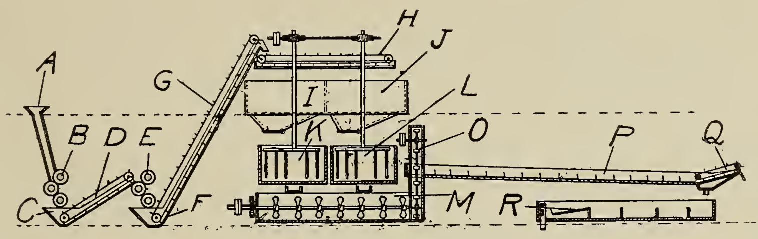


Fig. 317.—The Clark Conveyor.

to a horizontal conveyor H, which delivers it to storage bins I and J. The rubber is treated in the tanks K and L to remove the fiber, after which acid, water and rubber are discharged into the trough M. The liquid is drained off and the rubber, washed free of acid, is conveyed by a screw to a bucket elevator O, which finally discharges it into the sand and metal separating apparatus P. In the latter mechanism still another conveyor Q is employed to transfer the rubber to the catch basin R.

Devulcanizers.

As early as 1855, Sigismond Beers took out a patent for an "Improvement in Devulcanizing Rubber." While no illustrations were given, the process consisted in grinding the waste between rolls, then boiling it in an alkaline lye to extract the sulphur and devulcanizing by the use of turpentine and heat.

Three years later Hiram Hall was granted a patent for "Restoring Vulcanized Rubber" by first grinding the waste and then boiling in water for about 48 hours. He also described the use of sulphuric acid for "rotting the fabric." No description of the apparatus further

than referring to "cauldrons, kettles or tanks of any sort" is given. In a later patent he mentions a closed vessel for use under steam pressure.

The Richards Devulcanizer.

In 1860, A. C. Richards patented the apparatus shown in two views in Fig. 318. *A* is a horizontal iron cylinder supplied with steam

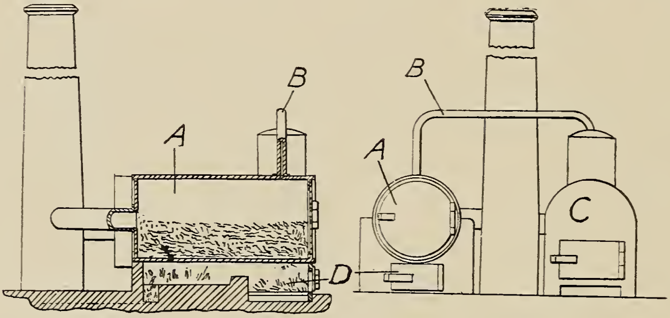


Fig. 318.—The Richards Devulcanizer.

through a pipe *B* from a boiler *C*. A fire is built in the furnace *D* under the devulcanizer, and the rubber heated to 600 deg. F. while the steam is being admitted.

Mitchell's First Devulcanizer.

Fig. 319 shows an apparatus patented by Mitchell in 1899, which discloses the art practically as it exists today. In describing his pro-

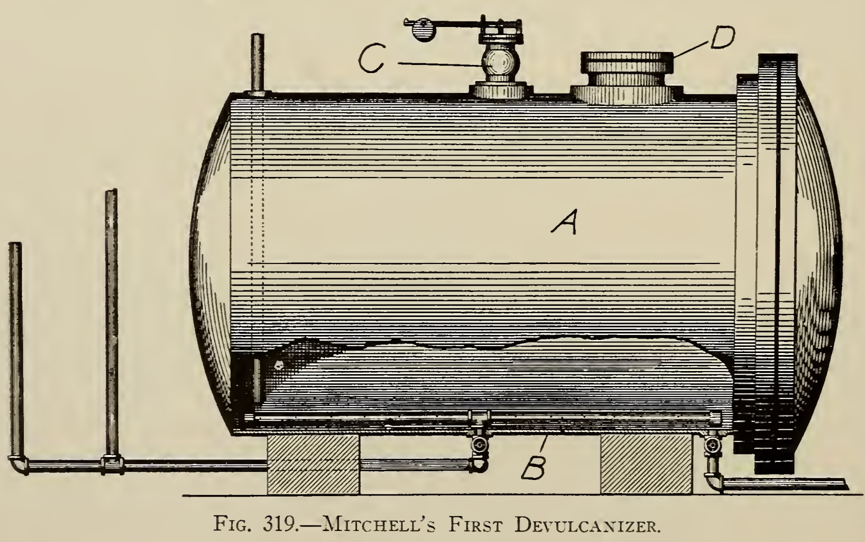


Fig. 319.—Mitchell's First Devulcanizer.

cess, the inventor says, "I have discovered that great advantages are secured by heating the reclaiming agent and the rubber waste together in a closed vessel under pressure above the ordinary boiling or vaporizing point of the solution employed as such agent."

The apparatus was very simple, consisting of a heavy horizontal iron cylinder *A*, with a perforated steam pipe *B* leading in from the bottom. It was fitted also with a safety valve *C* and filling manhole *D*. At one end of the cylinder was the usual heavy cast iron door, although no means was fastening it were shown.

The Mitchell Improved Devulcanizer.

A year later Mitchell invented a far better devulcanizer, which is shown in Fig. 320. This consists of a long iron cylinder *A* about 5 feet in diameter, with a track *B* inside, on which runs a car *C*. On the bottom of the cylinder are a series of heavy rakes *D*. These form

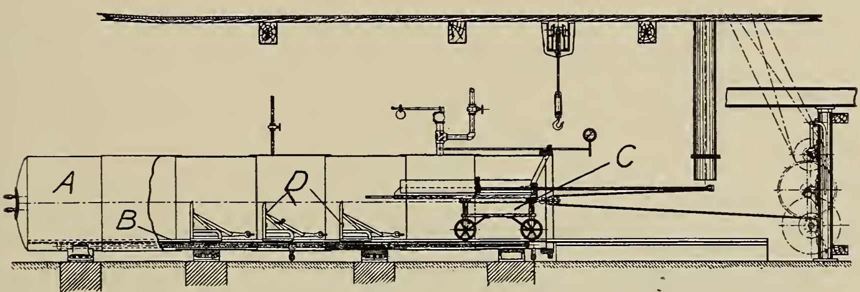


Fig. 320.—The Mitchell Improved Devulcanizer.

partitions and divide the waste and act like movable bins. In loading, a rake is put in position at the far end, the car is then run in and its load dumped upon the rake. This process is repeated until the cylinder is full. After devulcanization the rakes are pulled out one by one, thus removing the rubber.

The Marks Devulcanizer.

In 1899, Arthur H. Marks patented a process of devulcanizing waste rubber by submerging the finely ground waste in a dilute alkaline solution in a sealed vessel, then heating the contents of the vessel to a temperature of 344 deg. F. and maintaining that temperature for 20 hours. This apparatus was crude, and later Marks designed the apparatus shown in Fig. 321. Referring to the illustration, *A* is a horizontal steam-jacketed cylinder mounted on trunnions *B* and is slowly driven by belt pulley *F*. Steam is admitted to the jacket through

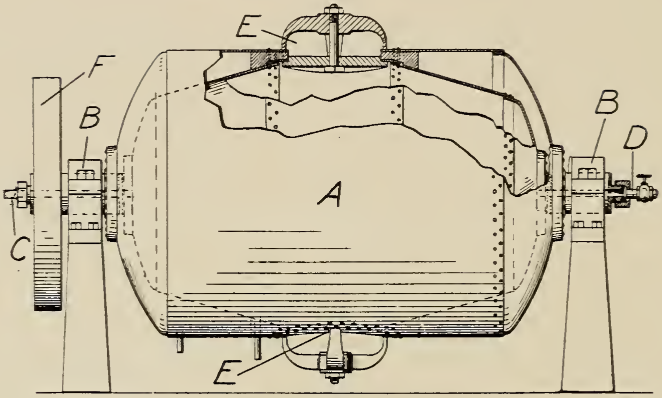


FIG. 321.—THE MARKS DEVULCANIZER.

a pipe *C* and exhausts at *D*. There are two manholes *E* for filling and emptying. This is practically what is used for devulcanization in all of the process factories.

THE BIGGS DEVULCANIZER.

The Biggs rotary jacketed devulcanizer, shown in Fig. 322, is a development of the one just described. It differs only in having several

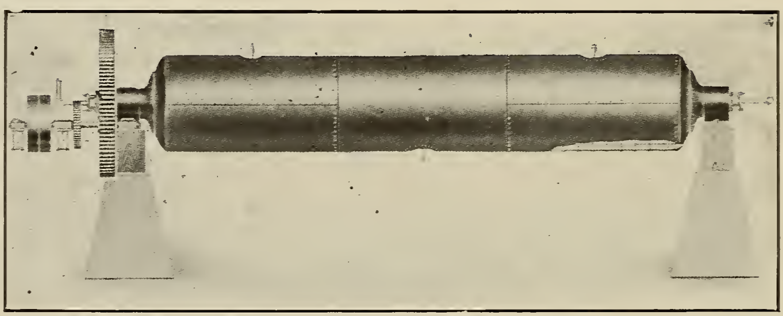


FIG. 322.—THE BIGGS DEVULCANIZER.

manholes instead of two. It is often fitted with agitators and used for extraction by chemical solution.

THE BLAIR DEVULCANIZER.

The devulcanizer shown in Fig. 323 has a horizontal jacketed cylinder *A* which revolves in bearings *B*, driven by a pinion and spur gear. The stirring blades *E*, attached to the center shaft, are stationary, while the blades *F* are attached to the cylinder and revolve with it. *C* is a steam pipe and *D* is a pipe for supplying water or caustic soda.

There are two manholes for filling or discharging, and the steam jacket and inner cylinder have independent relief valves.

The powdered wash is placed in the inner cylinder and treated with caustic alkali and water. Heat is then applied to the jacket and

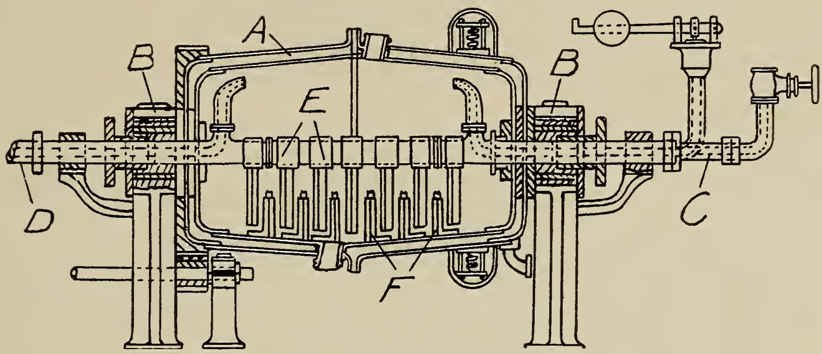


Fig. 323.—The Blair Devulcanizer.

the cylinder revolved. The stirring blades break up the rubber and make it plastic. It is then removed from the machine and washed and sheeted.

The Price Process.

In the Price process for alkaline recovery, the idea is to use alkali so concentrated that the boiling point without pressure other than atmospheric is high enough to devulcanize. The first patent, in 1902, is for an apparatus consisting of a devulcanizer in which the waste is stirred by a spiral, while steam is admitted either to the jacket or to the interior.

In another patent in 1904, Fig. 324, the apparatus consists of a tank *A* with a jacketed bottom *B* and a vertical shaft *C* having horizontal blades. The tank is fitted with a condenser *D*. The steam escapes at *E*, condenses in coils *F* and drips back, to keep the solution of constant strength.

Somewhat in this line is the Peterson devulcanizer. This is horizontal, and has a jacket and a stirring arrangement consisting of revolving paddles. This was designed that pressure be applied to the alkaline solution, the steam devulcanization being accomplished by phenol and alkali.

The Heller Electric Devulcanizer.

Fig. 325 shows an apparatus for devulcanizing with the aid of an electric current.

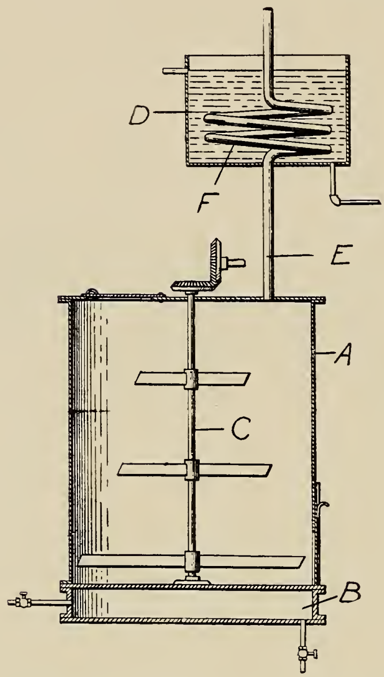


Fig. 324.—The Price Process.

In the illustration A is a cylindrical tank with a conical shaped bottom and contains a smaller, similarly shaped tank B. The upper ends of both tanks are closed by separate heads but have a common manhole and cover for filling. The space between these two vessels forms a heating chamber, which is supplied with steam through the inlet pipe C. In the lower end of the tank B is a funnel-shaped tank D, closed at its lower end by a valve F, which is operated by the lever G. Attached to its upper end is an open zinc cylinder insulated from D and connected to the electric battery L. The pipe H is attached to the outer tank and extends into the inner tank, one end terminating near the bottom of tank D and the other end being connected to the tank B by the opening I. A propeller J operated by a pulley on the shaft K forces circulation in the pipe H.

In carrying out the process a sufficient quantity of powdered waste is placed in the tank to cover the pipe H, the valve F being closed. The solution commonly used for each 100 pounds of rubber is 600 pounds of water, 21 pounds of sodium hydrate or potassium hydrate, and one pound of ferric sulphate. The material circulated through

the pipe H by means of the propeller J and the electric current, and the steam heat acts upon the mass as it passes up through the inner tank and around the zinc cylinder. This process is continued from 10 to 24 hours, after which the valve F is raised, allowing the solution to run down through the pipe M into the washing cylinder N. This washing tank is filled with hot water to remove

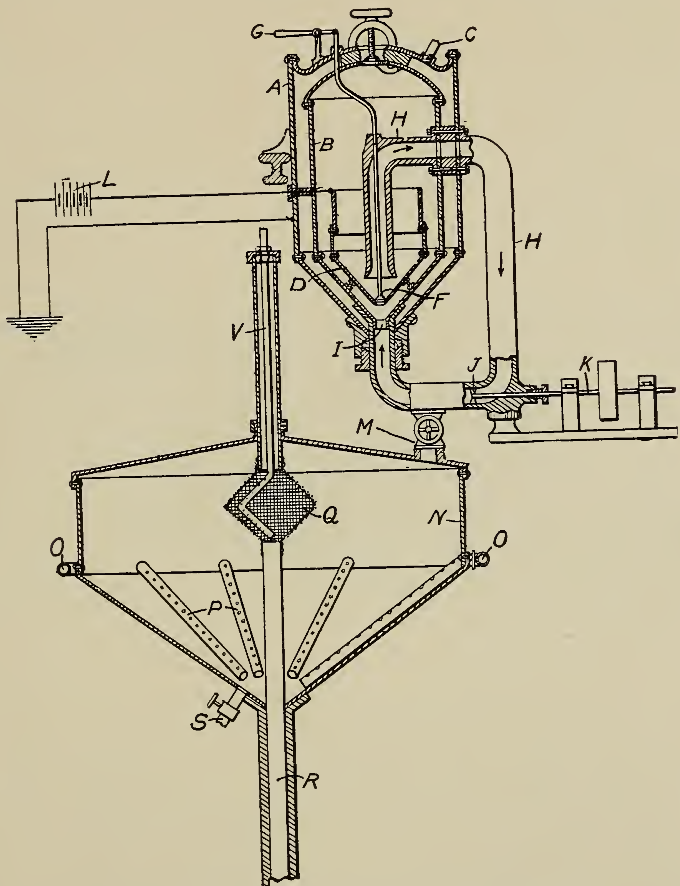


Fig. 325.—The Heller Electric Devulcanizer.

the chemicals, especially the caustic alkalies. In order to assist in cleansing the rubber steam is introduced from the pipe O surrounding the tank through the perforated pipes P. This agitates the solution and allows the rubber to sink to the bottom. The hollow screened body Q is then lowered into the solution above the rubber so that the waste water and chemicals are drained off through the pipe R. This

washing process is repeated, fresh water being introduced through the pipe V until all foreign materials are washed away from the rubber, after which the pure water and rubber are allowed to run out through the pipe S.

The Vaughn Water Separator.

Water remains in abundance in reclaimed rubber after treatment, and must be removed. Much of it is expressed mechanically, as in the Vaughn mechanical water separator, illustrated in Fig. 326.

This machine consists of a tapered cylinder and screw of like shape, with five screens fitted into the cylinder, three in the bottom half and two in the upper. Stock is fed in through a hopper on top and carried forward by the wings of the screw against a pressure cap at the opposite end. This pressure, together with the force applied from the screw, expels the moisture through the screens above referred to.

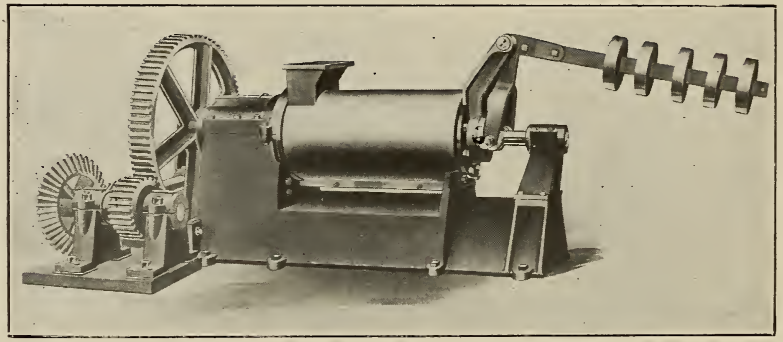


Fig. 326.—The Vaughn Water Separator.

The machine may run anywhere from 12 to 20 r. p. m., though ordinarily it is run at 15. It is rather hard to state what capacity can be delivered on the No. 2, or large size, but we imagine between 600 to 1,000 lbs. per hour, depending entirely upon the condition and grade of stock used. The amount of moisture removed will vary anywhere from 50 to 70 per cent. As far as the load is concerned, the operation is continuous, as the machine is usually filled from a conveyor.

Hot Air Dryer.

As for heated dryers, the ordinary apparatus is a large, flat, airtight box with a wire screen near the top, on which a layer of the wet reclaimed stock is placed. A fan forces air through steam coils, where it is warmed. The heated air passes under the box and rises through the screens on which the rubber is placed and dries it.

Continuous Screw Press.

The American Process Press, shown in Fig. 327, is of the continuous screw type and consists of a horizontal tapered screw built up on a hollow perforated shaft through which steam is admitted to the material. The close fitting screw rotates inside a similarly tapered, slatted curb. The gradual decrease in size of the screw and its curbs causes the pressure. The material cannot turn with the screw and slip on the curb, and must move towards the small end as the screw turns. The press is fitted at its discharge end with an adjustable cone arrangement so that the discharge opening can be regulated to the condition of the material being pressed. By adjusting the cone any desired pressure is produced in the press.

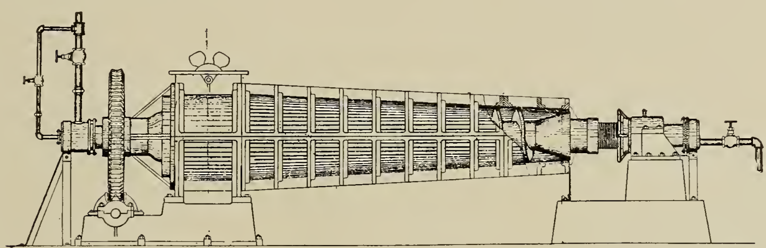


Fig. 327.—Continuous Screw Press.

Drainage is both internal and external. The large drainage area offered by the spaces between the slats of the curb, supplemented by the drainage holes in shaft, insures complete separation of the liquids. At each end of the shaft is a special stuffing box, with a movable diaphragm and perforations in shaft, which permit the use of steam on a portion or all of the press.

The material enters the feeder from a hopper and is mechanically measured, and forced into the straight portion of the screw. The screw carries it into the tapered curb and it is slowly and positively pressed. The material is continually fed in at one end and discharged at the other. The liquids are forced out between the slats and into drainage holes and are conducted to a tank. Generally, the pressed material falls into a screw or other conveyor and is carried away for subsequent treatment.

Hot Air Rotary Dryer.

Fig. 328 shows the American Process steam-heated rotary dryer. It consists of a fan blower *A*, heating coils *B* and a cylindrical steel shell *C*. Near each end of the shell is a steel tire *D*, which rests upon friction roller wheels *E*. These wheels are driven by a chain belt and

sprocket wheel *F* on the shaft *G*. The dryer is aligned so that the material moves gradually from the receiving end to the outlet.

The wet material is fed through a hopper *H* and comes in contact with the heated air from the steam coils. It falls to the bottom and is caught up by the ribs *K* and carried almost to the top of the cylinder,

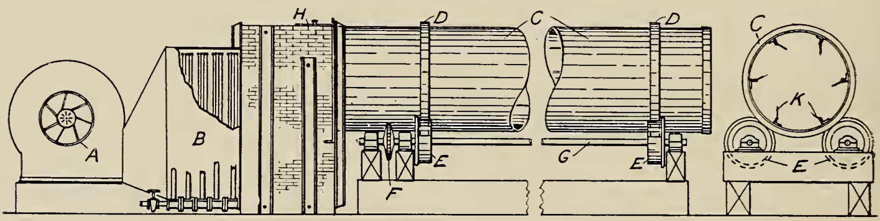


FIG. 328.—HOT AIR ROTARY DRYER.

where it is again cascaded through the hot air to the bottom. This is repeated until the dry product is discharged from the opposite end of the cylinder. The motion toward the outlet is caused by the slope of the cylinder but it is also assisted by the strong draft of hot air which is forced through the dryer by the fan blower.

THE CUMMER DRYER.

A self-contained type of direct heat dryer is shown in Fig. 329, which illustrates the apparatus with a section of the steel casing cut away to show the interior of the cylinder. The wet charge is fed continuously into the dryer through the feed spout *A*. The fan draws the heated air from the furnace through the hooded openings into the

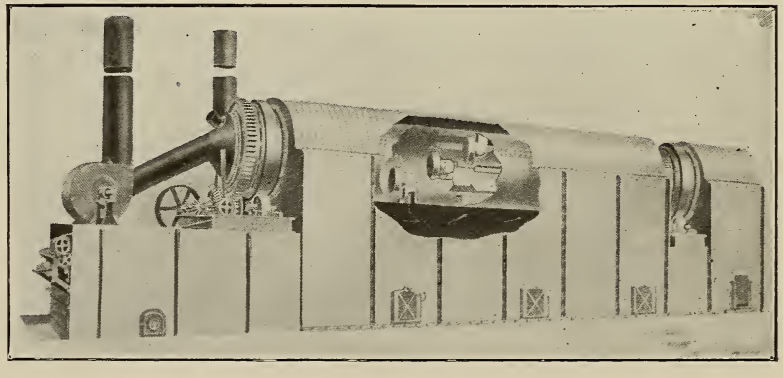


FIG. 329.—THE CUMMER DRYER.

cylinder, which revolves slowly. The lifting blades pick up and cascade the material through the heated air. As the charge travels through the cylinder the heat decreases and the moisture disappears from the material, until it is finally discharged at the end of the machine.

Rotary Vacuum Dryers.

The vacuum dryer is also largely used for drying reclaimed rubber. It is, briefly, a steam-jacketed cylinder, having heads fitted to each end. In it is a revolving tube for heating the interior, which also carries arms for agitating the material to be dried. The shaft for revolving this tube extends through a bearing in one cylinder head and has on the outside end a spur gear which meshes with a spur pinion on a countershaft underneath. On this shaft is a pair of tight and loose pulleys driven by belt from an overhead shaft. In the top of the dryer are two vertical loading apertures with removable covers. There is also an opening for the vacuum pipe, which connects with a condenser. In

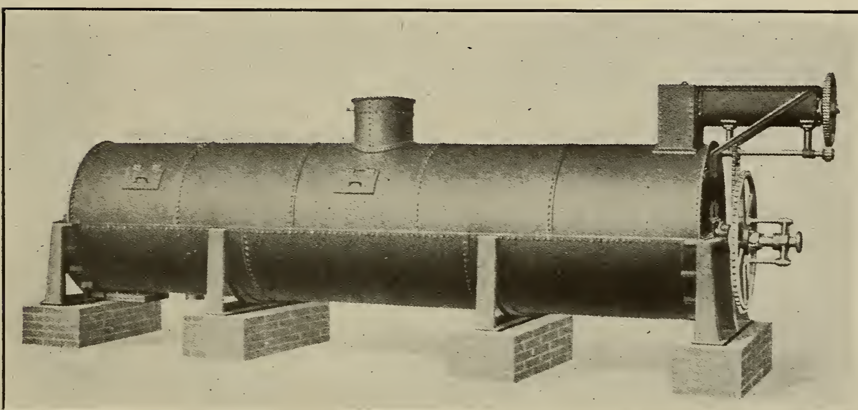


Fig. 330.—The Devine Rotary Dryer.

the bottom of the drying cylinder are two or more openings with hinged doors for unloading. The operation is practically the same as for the crude rubber vacuum dryer. A rotary vacuum dryer 3 feet in diameter and 20 feet long will dry about 3,000 pounds of reclaimed rubber in ten hours.

The Devine Rotary Dryer.

The dryer illustrated in Fig. 330 works under atmospheric pressure. It is a trough surrounded by a steam jacket, the former being covered by a sheet-iron dome fitted with vapor shaft and charging aperture. Within this trough rotates a tube drum, heated by live or exhaust

steam with blades attached—or in some cases a shaft only with blades attached—which effect a continual slow turning over and heating of the material. The dryer is fitted with a continuous automatic charging and discharging device. It can also be charged periodically. From 1.2 to 1.3 pounds of steam is required to evaporate 1 pound of water out of the previously heated substance that is to be dried.

Buffalo Vacuum Dryer.

The dryer illustrated in Fig. 331 has a hollow steam-jacketed cylinder fitted with heads at each end. In the center of the cylinder is a revolving heating tube, carrying arms and plates which effect a tumbling

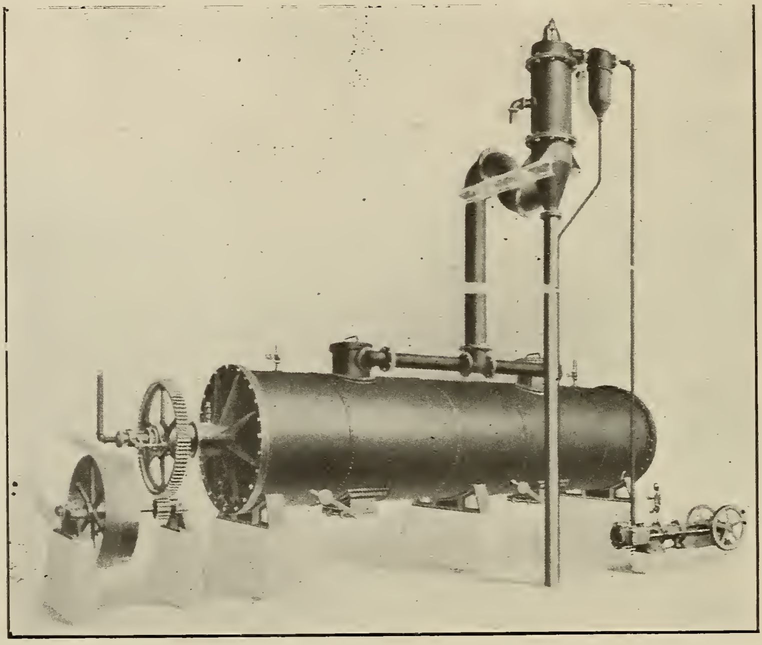


Fig. 331.—Buffalo Vacuum Dryer.

over or mixing of the material. In the top of the dryer are two apertures for loading and at the bottom two for unloading. The revolving parts are fitted with bronze bearings. It is operated in connection with a barometric surface condenser, depending on the amount of moisture or solvents being drawn from the material treated and whether or not it is desired to reclaim them.

Steam is supplied to the jacket of the casing and to the inner revolving tube. The chamber between the center tube and the jacketed

shell, after being loaded, is evacuated. This vacuum causes a rapid evaporation of the moisture and other solvents contained in the material. The vapors pass to the condenser, are condensed and either thrown away or reclaimed.

The Scott Dryer.

Another dryer of the vacuum type is shown in Fig. 332. *A* is a cylinder in which revolves a belt driven shaft *B* having concentric, spiral stirring blades *C* and *D*. The cylinder *A* is heated by the jacket *L* through steam inlet *M* and exhaust *N*. The air is extracted from

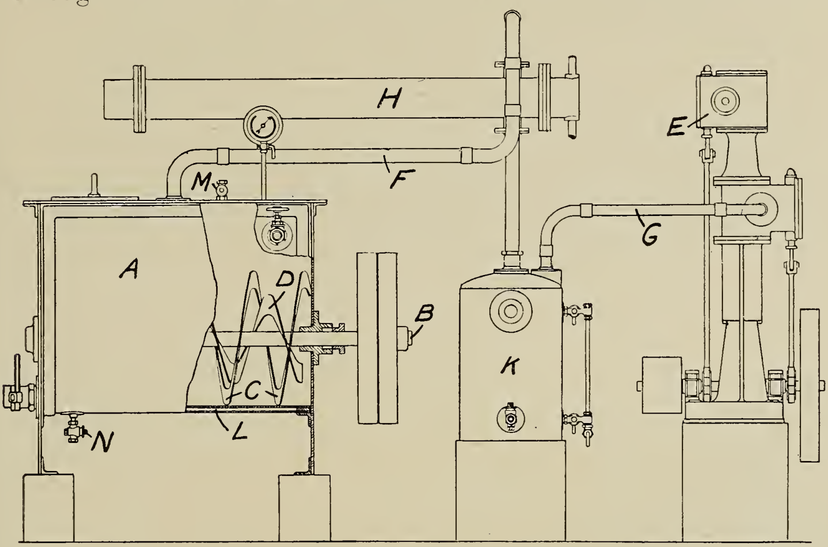


Fig. 332.—The Scott Dryer.

the cylinder by the pump *E* through the air lines *F* and *G* and the condenser *H*. The receiver cylinder *K* collects, measures and drains off the moisture from the rubber. In this way the percentage of moisture is determined.

The Stokes Dryer.

Another rotary vacuum dryer is illustrated in Fig. 333. The cylinder is steam-jacketed and fitted with a shaft which is driven by a spur gear and pinion from a belt driven countershaft. Both the cylinder and drive gearing are mounted on the same frame. Fixed to the shaft inside the cylinder are two sets of spiral stirring blades. The inner set throws the material away from the center and distributes it evenly throughout the length of the cylinder, while the outer set draws the material towards the center, where the discharge outlet is located.

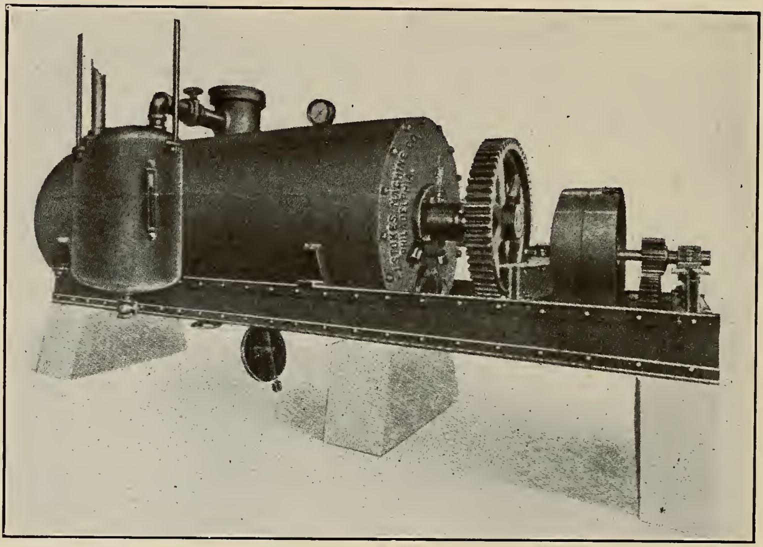


FIG. 333.—THE STOKES DRYER.

A vacuum pump, condenser, dust collector, gage and steam connections are part of the equipment. All joints and seams are electric welded. The bearings of the agitator shaft are adjustable so that the paddles can be raised and the bottom of the cylinder scraped clean.

CLEANING BY EXTRUSION.

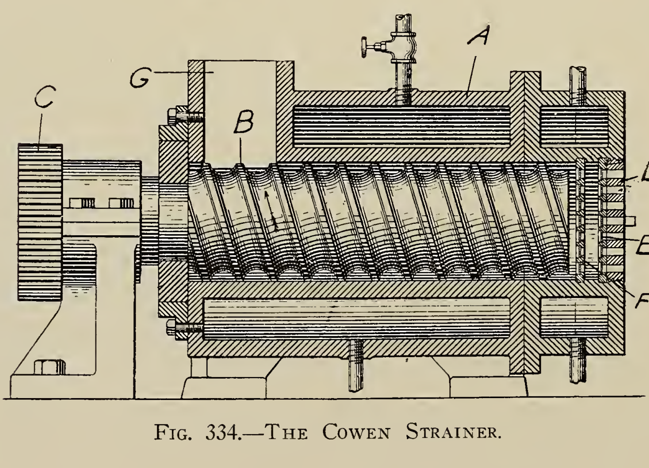


FIG. 334.—THE COWEN STRAINER.

The Cowen Strainer.

Fig. 334 shows the Cowen device for cleaning devulcanized rubber. It is similar to the ordinary tubing machine, and has a steam-jacketed casing *A* and a stock worm *B* driven by the gear *C*. At the front end of the cylinder is a thick plate *D* with large holes countersunk at the back to form seats to support small sieve discs *E*, one disc for each hole in the plate. Back of the plate *D* is a similar plate *F* containing sieve discs with larger perforations. The reclaimed rubber is fed into the hopper *G* and the stock worm carries it through the casing where the heat softens it. It is then forced out through the strainers by the worm, metal and other foreign matter being retained by the sieves. Provision is made for removing the screens for cleaning.

The Weir Strainer.

Fig. 335 shows longitudinal and cross sections of a strainer, to be attached to the cylinder *A* of a tubing machine having the usual

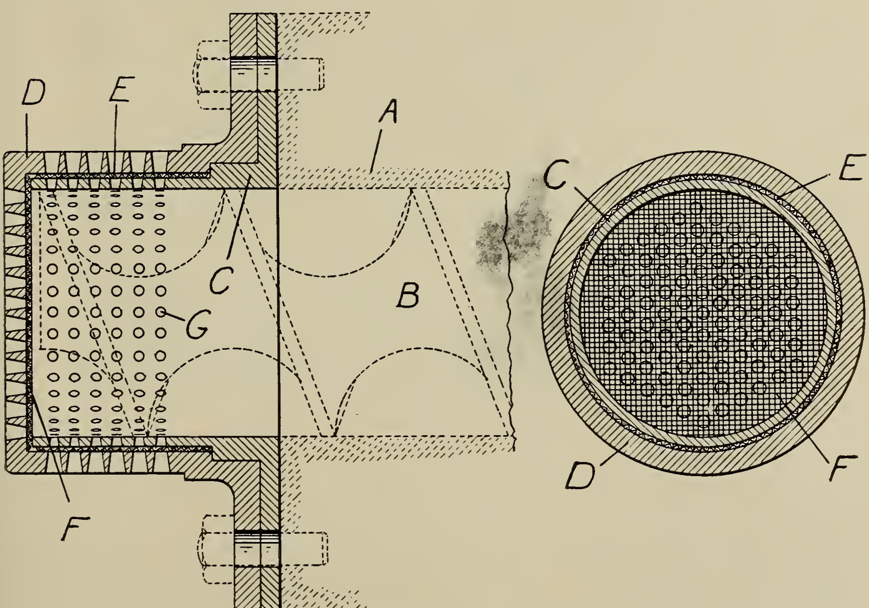


Fig. 335.—The Weir Strainer.

stock worm *B*. The strainer consists of a hub *C* and a cap *D*, between which are placed a ring-shaped screen *E* and a circular screen *F*, both with a fine mesh. The hub and cap are perforated with larger holes *G*,

which taper outwardly to provide easy escape of the extruded rubber. The screen E is placed between the hub and cap to prevent it from coming in direct contact with the screw. Having the screen in the walls as well as in the end of the head provides a much greater straining surface.

Royle Three-Way Head Strainer.

In Fig. 336 is shown a reclaiming strainer designed for heavy work. The body of the machine is supported on a broad, square base. It is chambered for heating or cooling, and accurately bored to receive the large and powerful stock worm driven by a belt and cut spur gear-

Fig. 336.—Royle Three-Way Head Strainer.

ing. The three-way head has heating or cooling chambers, and the holes in the plates are square instead of round. The usual wire gauze strainers can be removed for cleaning by unscrewing the octagonal headed bushings with the special socket wrench provided for that purpose.

The Mitchell Sheeting Mill.

The final process in reclaiming is sheeting, and perhaps refining. This is done on ordinary or special mills similar to the standard rubber mixer. Of the special types that designed by Mitchell, and shown in Fig. 337, is of interest.

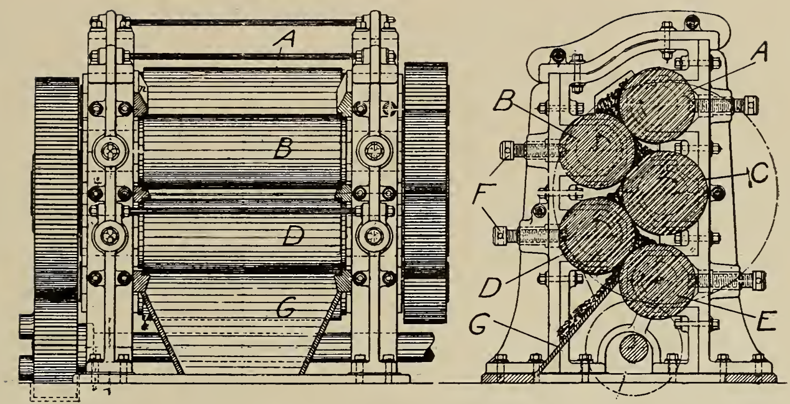


FIG. 337.—THE MITCHELL SHEETING MILL.

This mill has five rolls, *A, B, C, D* and *E*. All are 16 inches in diameter except roll *C*, which is 18 inches. They are geared to run at the same surface speed, roll *C* running at 25 r. p. m. The four smaller rolls are adjusted by screws *F*. The reclaimed rubber is fed in between the upper rolls *A* and *B* and passes through the mill as shown, after which it falls down the inclined plate *G*.

REFINING.

Refining reclaimed rubber consists in passing the sheeted stock through a set of smooth rolls set close together, producing a thin sheet.

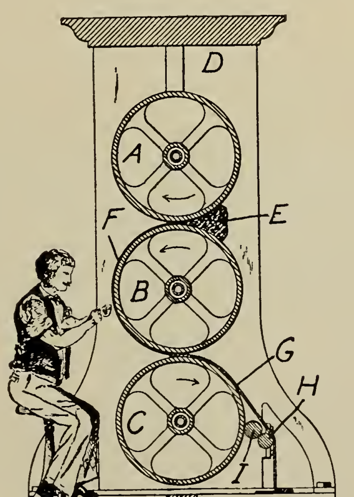


FIG. 338.—THE CABLE REFINING CALENDER.

Often a boy scans the sheet and picks out impurities. The refiner itself forces many particles to the sides of the rolls and enables them to be more easily removed. Ordinary refining is done on two rolls.

THE CABLE REFINING CALENDER.

A three-roll refining calender, which sheets and refines at the same time, is shown in Fig. 338. The rolls *A, B* and *C* are mounted in the standards *D* of the frames, the middle roll *B* in fixed bearings, while the rolls *A* and *C* are adjustable vertically. The plastic mass of rubber *E* is spread uniformly over the surface of the roll *B* and passes before the workman, who removes the impurities. The rolls *B* and *C* are set about twice as far apart as rolls *A* and *B,* and are geared together so that the lower roll revolves with about half the surface speed of the other. This difference in speed causes the rubber sheet *G* to part from the middle roll and move down on the opposite side of the slow roll *C*. In consequence the soft rubber sheet substantially doubles in thickness.

Back of the lower roll *C* is the small delivery roll *H* revolving at a surface speed faster than roll *C* driven by a friction wheel *I*. This receives the thickened sheet *G* from the roll *C* and deposits it on the platform in layers for further treatment.

RECLAIMED RUBBER PRESS.

The press illustrated in Fig. 339 is used for pressing reclaimed

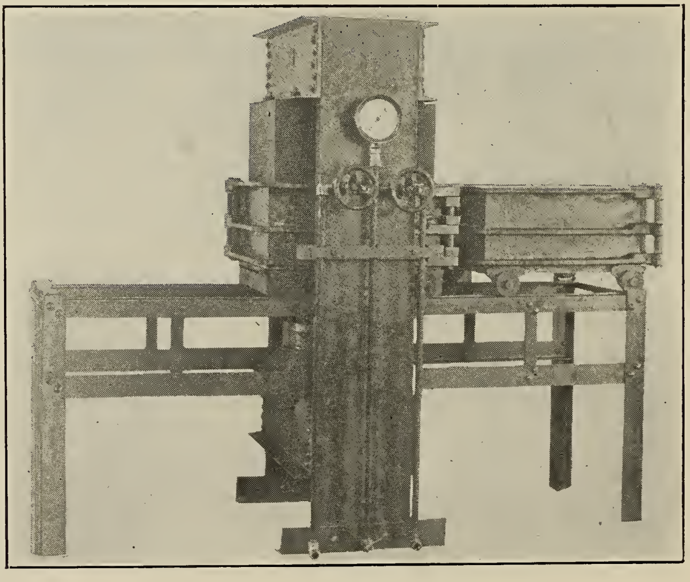


FIG. 339.—RECLAIMED RUBBER PRESS.

rubber into slabs. It is operated by hydraulic pressure through an accumulator or from a single pump installation. The apparatus is of the upward pressure type, the ram having a working pressure of 1,000 pounds, with a travel of 13 inches. A track running through the press between the frame members carries two steel mold boxes which receive the rubber and carry it into the press. One box is always in position for unloading and refilling while the other is under pressure. One side and end of each mold box are provided with hinges which permit the boxes to be opened for removal of the pressed rubber. The pressure head is machined to fit the boxes, which are 22 inches wide, 26 inches long and 13 inches deep. When pressure is applied, the box with the rubber is forced upward and over the pressure head, and the rubber is pressed into a slab in the bottom of the box. The machine is fitted with the usual hydraulic gages and valves for controlling and registering the pressure. The apparatus is constructed of steel throughout, which adapts it for long and hard service.

The Reforming of Rubber Waste.

By reforming is meant the remolding and revulcanizing of ground vulcanized scrap without reclaiming. A few years ago in England

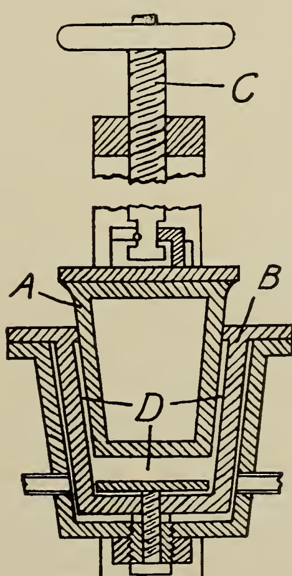


Fig. 340.—The Hayward Reforming Mold.

this subject attracted much attention. It was not altogether new, however, for in 1854 Daniel Hayward patented a reforming process.

The Hayward Reforming Mold.

This device is shown in Fig. 340, as applied to the manufacture of rubber buckets. Both the inner die *A* and the outer mold *B* are cored for steam or water as required. By a hand screw *C* pressure is brought to bear upon the rubber in the mold space *D*.

The Gare Process.

In 1910, Gare, an Englishman, took out many patents for a process analogous to Hayward's, but which went much farther. The Gare process consisted in taking waste rubber and grinding it by special grinders into a fine powder. Afterward this was placed in a cold mold; then pressure was applied to expel the air. Finally the mold and powdered rubber waste were heated to a temperature of about 400 deg. F.

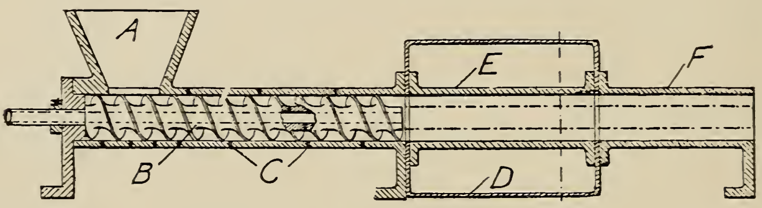


Fig. 341.—The Gare Reforming Machine.

The difference between the above methods and those (except the high temperature) known to rubber manufacturers will not be apparent at first sight; but there is one difference—the applying of pressure to the mold before the application of heat. Gare heated the waste rubber far above the vulcanizing temperature—i. e., 400 to 450 deg. F. The effect of the intense heat during the process, so Gare claimed, was to accomplish the perfect mechanical fusion of the particles of powdered vulcanized waste rubber.

The Gare Reforming Machine.

In the manufacture of cab tires, Gare's process was in general the same as that described above. One form of machine used is shown in Fig. 341. Referring to the drawing the powdered stock is fed through a hopper *A*, and the stock worm *B* compresses and forces it into the mold. The air escapes through holes *C* in the casing or through the hollow shaft of the screw. The stock, heated by a steam jacket *D*, passes through the mold part *E*, where it is shaped and vulcanized and is cooled as it passes out through the part *F*.

CHAPTER XIX.

TEMPERATURE RECORDING AND CONTROLLING DEVICES.

A GREAT variety of instruments for recording and controlling temperature and pressure during vulcanization are in use, and their importance can hardly be overestimated. The thermometer, or steam gage in some form, is always present, always necessary. Not only are the various devices important but the manner of application is of moment. None of the controlling devices, for example, are effective unless the vulcanizer or press produces even cures. Over-taxing the capacity of the main steam line is often supplemented with other faulty piping and will result in uneven cures. In many cases a long vulcanizer is supplied with steam from one connection, usually at the head. This cannot insure uniform heating, as the end nearest the steam inlet heats first.

All long vulcanizers should be provided with three or four inlets, spaced to insure rapid and uniform distribution of the steam. Vulcanizers are rarely provided with blow-offs on the upper side; consequently air is trapped, and irregular curing results. The best way is to provide a large exhaust and open it wide, to be closed when the steam escapes in good volume. This will drive out all air, and cause the steam to circulate uniformly.

Steam with water in suspension is not as hot as dry steam and retards the cure. To cure in dry steam, three factors are required,—dry incoming steam, rapidity of circulation and quick discharge of the wet steam and condensation.

When steam is turned into a large vulcanizer, the condensation is rapid. This should be discharged rapidly, to equalize the heat; therefore it is necessary to open the discharge valve wide. When the steam leaves the discharge pipe bluish in color, condensation has ceased and the discharge valves can then be throttled to permit the water to pass out freely; or a good trap can be used to advantage.

Where pressure gages only are used in vulcanizing, it is not unusual to find no two gages indicating alike. This is easily accounted for, since Bourdon springs cannot retain their accuracy any length of time and must be often tested and adjusted. Steam control of a vulcanizer

or press should always be done by temperature observation along with pressure recording.

When gages alone are used they may be misleading, for should the platens fill with water the gage will not indicate the fact. Recording thermometers or gages are most desirable adjuncts, as they give a true record of conditions. The hand control of a vulcanizer or press is accomplished by throttling the steam valve. If the steam pressure was always uniform the valve might be so nicely throttled that the temperature could be maintained without appreciable variation, but it varies, and the valve must be constantly turned. That is why pressure governors and automatic regulators are used in so many of the larger works.

The proper placing of the thermometer also merits careful consideration. The bulb should not project inside a vulcanizer far enough to be struck and broken. It should be enclosed in a special fitting, provided with a vent cock, which should be wide open when steam is turned on and afterwards throttled so that just sufficient steam escapes to keep up a good circulation around the thermometer bulb. Instead of the special fitting, a nipple and tee can be used with the vent cock or valve screwed in the side outlet of the tee.

On presses, the thermometers being on the side, it is often impossible to screw them directly into the platens. It is therefore necessary to use the special fitting. Sometimes a nipple with a coupling is screwed into the top of the vulcanizer or side of the press and the thermometer screwed into it. Such arrangement is bad. The thermometer cannot indicate the true temperature, as air pockets in the fitting and steam cannot circulate freely around the bulb. Thermometers are often used where small particles of mercury are lodged in the tube above the main column. This creates an error, and should be corrected as soon as observed. On long vulcanizers it is desirable to have two or three thermometers in order to note the temperatures in different parts. A thermometer near the door is not well placed, because the radiation of heat by the uncovered door lowers the temperature. On long presses it is desirable to have two or three thermometers on each of the platens.

Pressure Regulators.

When steam at a lower pressure than that carried on the boilers is used, it is necessary to employ some type of regulating valve to maintain a constant pressure and temperature. A number of such valves are manufactured, several of which are illustrated herewith.

THE MASON REDUCING VALVE.

Fig. 342 illustrates the Mason reducing valve, designed to automatically maintain an even reduced steam pressure regardless of the variation of the initial boiler pressure. In operation, the valve is controlled by the variation of the reduced pressure acting through the port *A*, on the diaphragm *B*, which is resisted by spring *C* that is adjustable to the desired reduced pressure. The diaphragm will rise with an increase of the reduced pressure and is forced down by the

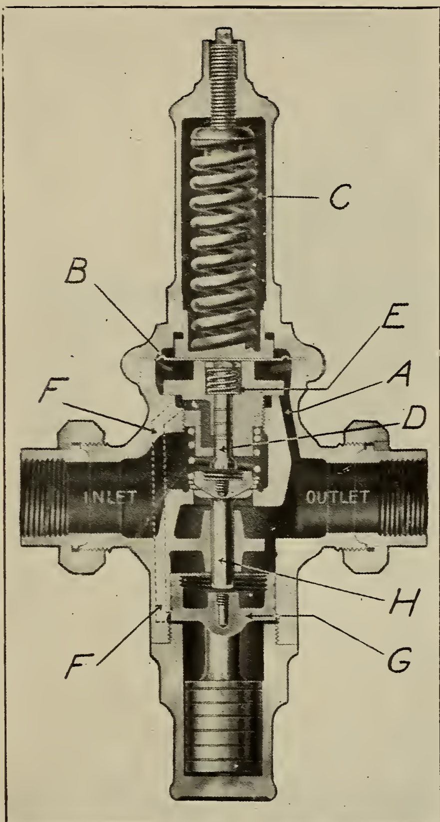


FIG. 342.—THE MASON REDUCING VALVE.

spring *C* when the reduced pressure is decreased. As the diaphragm is balanced between these two forces, any slight change of reduced pressure will cause a movement of the diaphragm.

An auxiliary valve *D*, held in contact with the diaphragm by the small auxiliary spring *E*, moves up and down with the diaphragm. When the valve *D* is open, steam passes through the port *F* and under the

piston *G*. This opens the main valve *H* against the initial pressure and steam is admitted to the system.

When the pressure has reached the required point—which is determined by the main spring *C*—the diaphragm is forced upward by the low pressure which passes up through the port *A*, thus permitting the valve *D* to close and shut off steam from the piston *G*. The main valve is then forced to its seat by the initial pressure, shutting off steam from the system and pushing the piston *G* to the bottom of its stroke.

In practice the main valve does not open or close entirely with each slight change of pressure but assumes a position to supply just the amount of steam to maintain the desired pressure.

The Watson-McDaniel Valve.

A different type of reducing valve is shown in Fig. 343. It is only necessary to set the weight *A* on the lever *B* at a point where the steam gage indicates the desired pressure. Steam enters the valve body

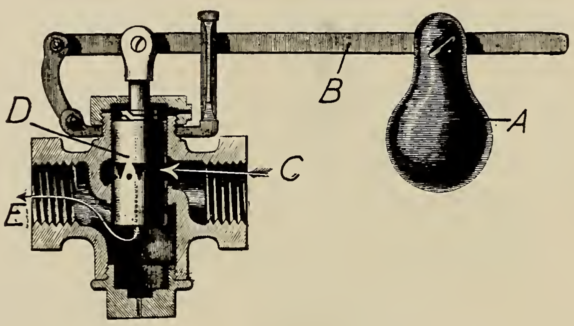


Fig. 343.—The Watson-McDaniel Valve.

at *C* and passes through small holes into the hollow piston *D*, then out of the valve at *E* and into the system. When the pressure on the low-pressure side becomes great enough to overcome the force exerted by the weight and lever, the steam forces the piston up and closes the holes or ports. The valve adjusts itself to feed just enough steam to keep the required pressure in the system, the variation in boiler pressure not affecting its operation, because the valve is controlled by the steam on the low-pressure side.

The H. and M. Pressure Regulator.

The principle of operation of this controller is the counter-balance of steam pressure by weight. It is operated by compressed air. Referring to Fig. 344, the regulator is attached to the vulcanizer by the

union A so that there will always be a water seal under the diaphragm B. The steam enters the valve M through the end marked "inlet." The union C is connected to the air pressure supply. By manipulation of the sliding weights D and E on the lever arm F, and the addition of weights placed on the hanger G, any desired pressure can be obtained. The weights are all marked in pounds and the lever arm is graduated. When the regulator is set at the desired temperature, air pressure is turned on, and steam is admitted at A. As soon as the temperature in the vulcanizer rises beyond the desired point, the pressure on the dia-

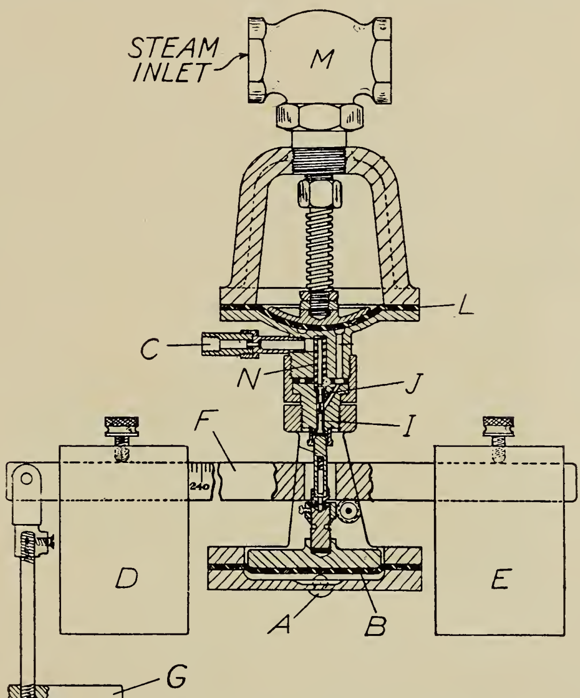


FIG. 344.—THE H. & M. PRESSURE REGULATOR.

phragm B overcomes the weight on the lever arm F, closing the valve I and opening the valve J. This allows the air pressure from C to enter the diaphragm chamber, inflating the diaphragm L and shutting off the steam in the supply valve M. As soon as the temperature drops, the weights on the lever arm overcome the pressure on the diaphragm B. This is forced back in place, cutting off the air supply, which allows the valve M to open and steam again enters the vulcanizer. In actual working conditions this regulator is so sensitive that the steam is throttling all the time.

THE SQUIRES VALVE.

In some types of reducing valves the main valve is operated by the initial pressure. Fig. 345 illustrates a valve which is controlled by a pilot valve *A*, and governed by the low-pressure side. The pilot valve is piped to the high-pressure side of the shut-off valve in the steam line of which the pressure is to be reduced. The outlet *B* at the top of the pilot valve is connected to the reduced pressure side.

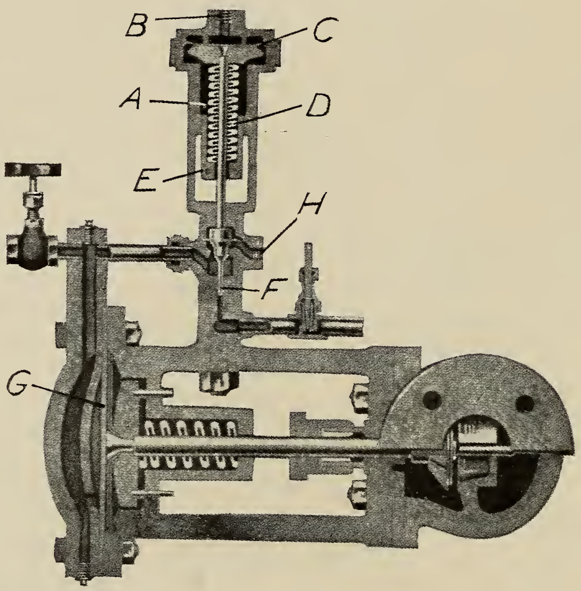


FIG. 345.—THE SQUIRES VALVE.

In operation, the reduced pressure, acting on the diaphragm *C* of the pilot valve, is balanced by the tension of the spring *D*, which tension is adjusted by the nut *E*. When the reduced pressure overcomes the spring, the pilot valve will seat and steam will seep past the resistance plug *F*, thus increasing the pressure on the main diaphragm *G* and decreasing the main valve opening. If the reduced pressure is overcome by the spring, the pilot valve will lift from its seat, opening the exhaust port *H* to the atmosphere. The pressure is then reduced on the main diaphragm and the main valve will open, allowing more steam to enter to the reduced-pressure side of the valve. The continuous opening and closing of the main valve maintains the reduced pressure for which the valve is set.

The Davis Regulator.

The regulator shown in Fig. 346 is designed for the reduction of steam from any initial pressure to any delivery pressure. Steam enters the high-pressure chamber and, in passing through the seats into the cylinder, tends to force the piston upward and close the inner valve to which it is attached by a link. This tendency, however, is counteracted by weights suspended from the lever which is connected to the piston by a yoke and stem. Thus a balance between the steam pressure and the weight is attained.

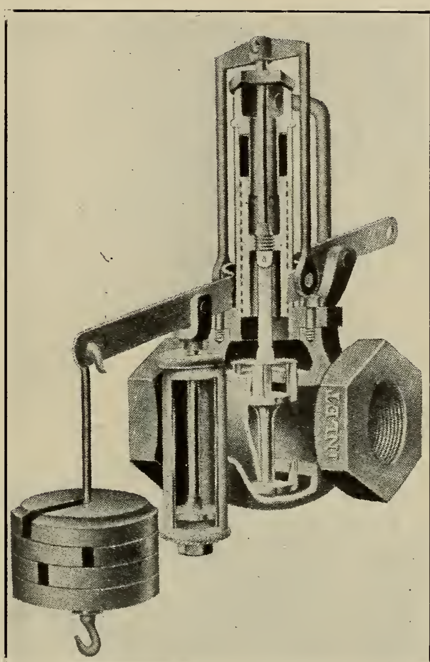


Fig. 346.—The Davis Regulator.

If the delivery pressure increases it forces the piston up, and the inner valve closes somewhat and throttles the pressure until a balance is again reached. If the delivery pressure decreases, the weights carry the piston down and the inner valve will open wider; the pressure under the piston, therefore, increases until it again balances the weights. This repeated action maintains a constant delivery pressure, which is increased or decreased by adding or removing weights.

THE SARCO THERMOSTATIC REGULATOR.

The regulator illustrated in Fig. 347 operates on the thermostatic principle, using as its motive power the expansion of a sensitive liquid hermetically sealed within a chamber into which is inserted a flexible corrugated tube.

The regulator is made up of the thermostatic element *A*, which is inserted in the vulcanizer, the controller element *B* and the valve *C*.

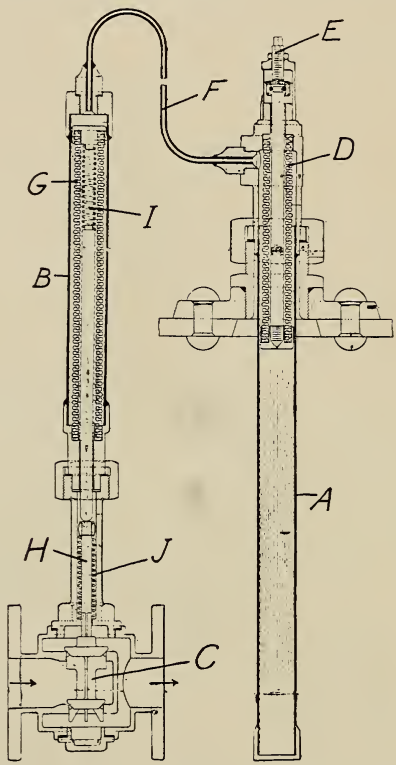


FIG. 347.—THE SARCO THERMOSTATIC REGULATOR.

The element *A* contains a heavy hydrocarbon oil, into which is inserted a piece of crimped copper tubing *D*, the length of which is extended or reduced by turning the regulator head *E*. From this thermostatic element a piece of fine copper tubing *F* runs to the controller *B*, which also contains a crimped copper tube *G* capable of compression when an increased temperature causes the liquid in the tube *A* to expand.

When the temperature increases in the vulcanizer into which the tube *A* is inserted, the pressure in the tube increases and is transmitted

to *B,* causing a compression of the tube *G,* which forces the piston *H* down and tends to close the valve *C.* The springs *I* and *J* operate in the opposite direction and tend to keep the valve open, which action is accomplished as soon as the pressure and temperature in the vulcanizer are reduced. Any change in pressure, and consequently any temperature change, tends to either open or close the valve *C,* thus keeping temperature constant.

The Atwood & Morrill Regulator.

The combination regulator shown in Fig. 348 is controlled by steam and water pressure. *A* is a cord that runs from the weighted piston rod *E* and is attached to the lever *B* of the valve *C* in the steam

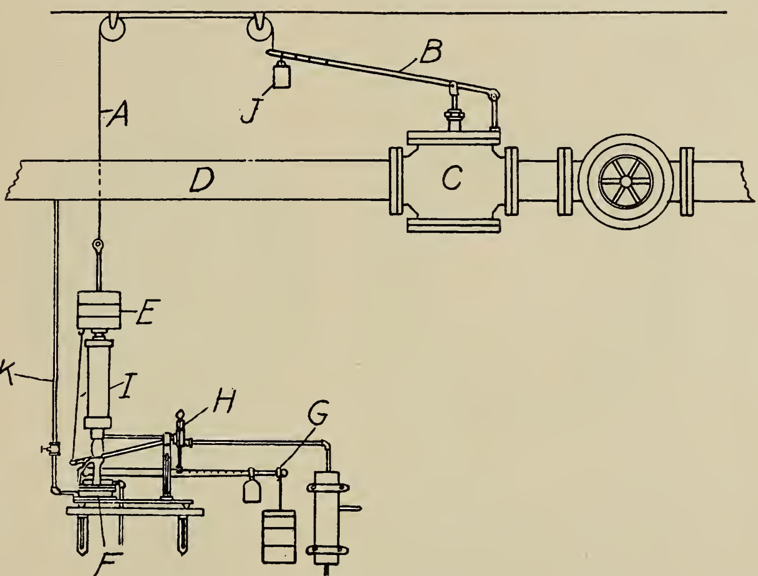


Fig. 348.—The Atwood & Morrill Regulator.

supply pipe *D.* When the piston *E* is in the position shown the valve *C* is open. As soon as the pressure in the discharge end of the steam pipe *D* reaches a predetermined point the pressure is exerted through pipe *K* on the diaphragm of the regulator in the casing *F.* This forces up the weighted lever *G,* which in turn operates the water valve *H,* admitting water pressure into the cylinder *I.* The water pressure forces the piston *E* up, which permits the weight *J* to close the valve *C,* shutting off the supply of steam.

When the pressure in the pipe *D* is reduced the weighted lever *G* overcomes the pressure exerted against the diaphragm in *F* and assumes

a lower position. The water valve *H* is brought to the discharge position and the water pressure in the cylinder *I* is released. The weights *E* force the piston down, which opens the valve *C* and allows more steam to enter the pipe *D*.

Steam Gages.

The purpose of a steam gage is to indicate the pressure in pounds per square inch by an index and a graduated dial.

American Pressure Gage.

Fig. 349 shows two views of the ordinary type, in which *A* is an elliptical metal tube connected at one end to a steam pipe *B* and at the other end with levers and gearing *C*. The greatest breadth of section of the Bourdon tube *A* is perpendicular to the plane in which it is curved. When the pressure inside the tube, which is filled with water, is greater than the external pressure, it tends to straighten, causing the

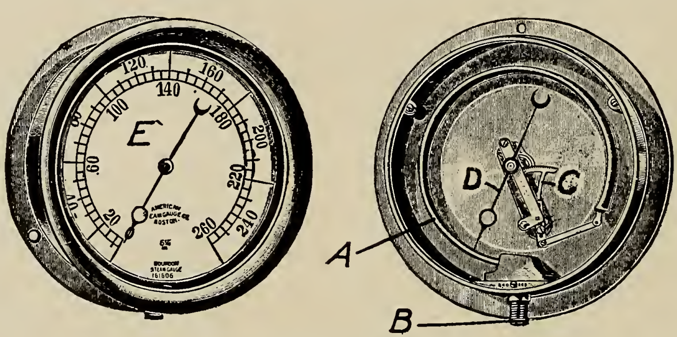


Fig. 349.—American Pressure Gage.

sector to move the index *D*. This indicates the pressure on the graduated dial *E*. An inverted siphon pipe is usually placed below the gage, its object being to contain water and thus prevent the heat of the steam from injuring the mechanism of the gage or distorting its action by expansion.

A steam gage is apt to get out of order in consequence of water lodging in the end of the tube and corroding it. Consequently, it should be tested frequently, either by a gage known to be correct or by a testing machine. Steam should never be allowed to act directly on a steam gage, and when exposed to the cold it is liable to freeze. The ordinary steam gage registers pressures above that of the atmosphere, the total pressure being measured from a perfect vacuum, which will add 14.7 pounds in the average to the pressure shown on the steam gage.

Vacuum Gages.

Gages are also used for indicating the amount of vacuum in a vessel.

The Tagliabue Vacuum Gage.

The gage illustrated in Fig. 350 indicates regardless of the state of the barometer. The scale is so graduated that adjustment for the varying level of mercury in the system is not necessary.

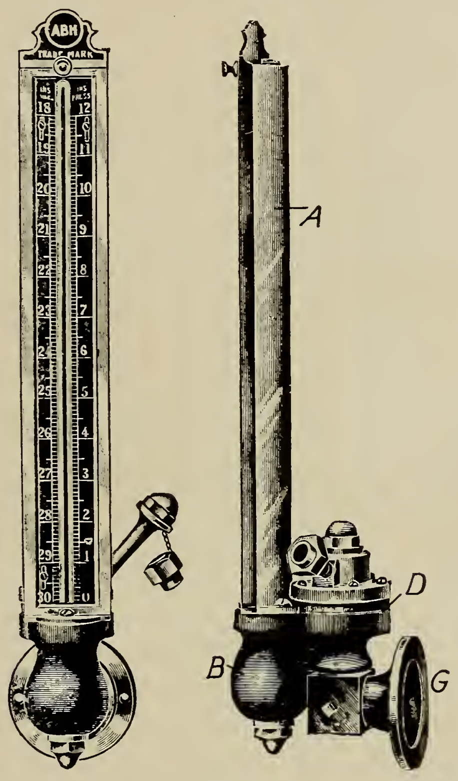


Fig. 350.—The Tagliabue Vacuum Gage.

The glass tube is sealed at the top and open at the bottom. It is filled with mercury, which is then boiled. The glass is protected by a scale case *A*. The lower end is open and extends into a mercury well *B* 1/8-inch from the bottom. It has a stuffing-box and the end of the glass tube is always surrounded by mercury. The well *B* and level chamber *D* are connected by a channel, the level chamber being filled with mercury to the zero degree of the scale. The gage is flanged at *G* for connecting to the vessel in which the vacuum is to be maintained.

When a vacuum is applied to the gage the mercury will drop in the tube, due to the absolute vacuum in it. and as the top of the tube is sealed, no air can enter. Barometric changes will not affect the accuracy of the gage.

Recording Gages.

It is often desirable to have a record of the steam pressure or vacuum carried in a vessel. The steam or vacuum gage will indicate the pressure or vacuum carried at the time of reading but keeps no record of their performance. A recording instrument will trace on a revolving chart, by means of a pen, the pressure carried for a period of 24 hours, when a new chart is placed on the dial. These charts are saved for reference and show the pressure carried at any time during the 24 hours.

The Bristol Recording Gages.

The illustration, Fig. 351, shows the original form of the recording pressure and vacuum gages made by the Bristol company. In the

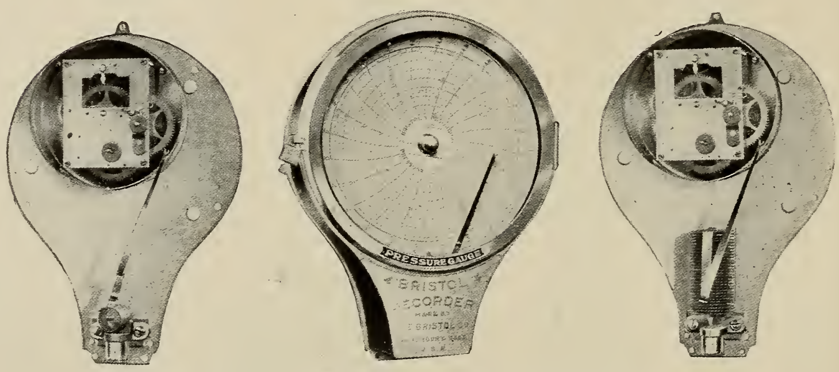


Fig. 351.—The Bristol Recording Gage.

center is the pressure gage with switch board form of outer casing common to both the pressure and vacuum gage. The charts and operating mechanism, however, are different. On the left is shown the mechanism of the gage. It is for recording high pressures up to 12,000 pounds per square inch, used for steam, air, gases or liquids, and made to read in pounds, ounces, inches, feet, metric or any desired units. The recording arm is attached directly to the moving element, which consists of a helical tube with several convolutions, giving ample motion without overstraining. The chart is moved by a reliable clock movement.

On the right is shown the mechanism of the low pressure vacuum gage for total ranges from full vacuum to 6/10-inch of water. The even scale chart, operated by a special clock movement, is graduated for range of 0 to 30 inches of mercury or full vacuum. The diaphragm types of pressure tubes are used, to which the recording arm is directly attached.

Precision Recorder.

Fig. 352 shows a recorder which uses a Bourdon tube for high pressures. For low ranges the conditions of pressure are transmitted

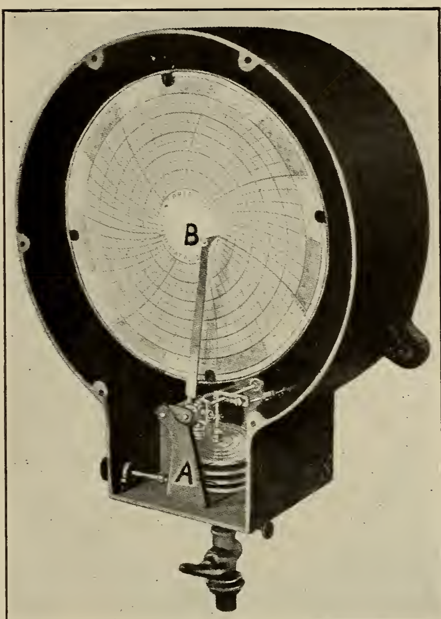


Fig. 352.—Precision Recorder.

by flexible diaphragms *A*. These consist of two strata of metal of equal expansion, one used for its elasticity and the other for its ability to resist corrosion and the action of acids. The pressure is transmitted from these diaphragms or chambers *A* to the pen *B* by an arrangement of levers, so adjusted that a correct record is obtained over any part of the chart. The instrument is made to register either pressure or vacuum.

Precision Continuous Recorder.

A continuous recorder is shown in Fig. 353. The system of transmitting the pressure is the same as used in the preceding instrument,

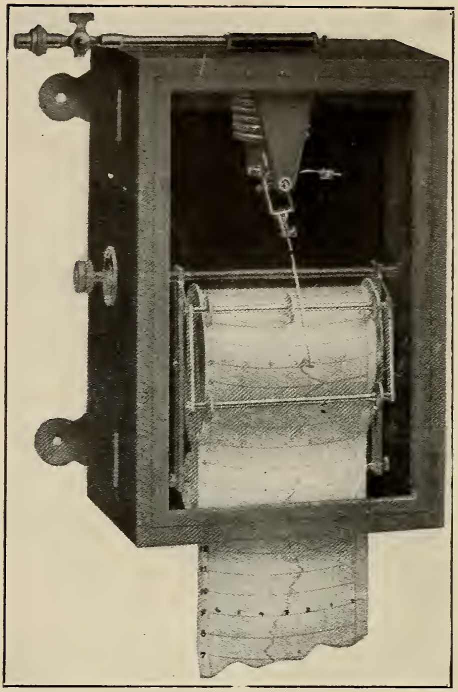


FIG. 353.—PRECISION CONTINUOUS RECORDER.

but there is a difference in the method of recording. The record is not made on a chart that requires changing every 24 hours, but upon a roll of chart paper which can be torn off at any desired intervals, the roll lasting 60 days. The record is always visible.

RECORDING AND ALARM GAGES.

Several styles of pressure recording and alarm gages are made.

THE EDSON GAGE.

This is shown in Fig. 354. It is suitable for use with steam, water or any other liquid except ammonia. The gage is connected to an electric bell which sounds an alarm when a predetermined high or low pressure is reached. The recorder has a chart speed of one-half to one inch per hour. The gage can be had for recording vacuum or for recording both pressure and vacuum.

THE IDEAL GAGE.

An alarm gage designed for pressure or vacuum is shown in Fig. 355. Combined with the gage is an automatic electric circuit-closing

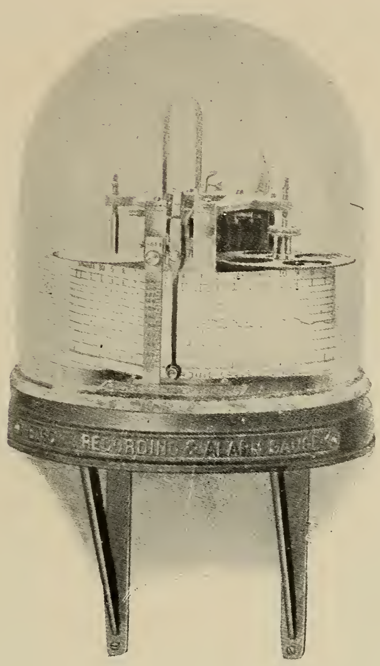


Fig. 354.—The Edson Gage.

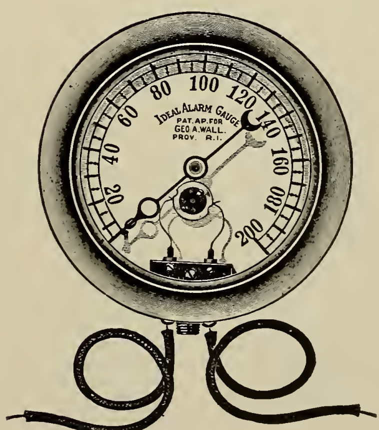


Fig. 355.—The "Ideal" Gage.

attachment, which rings a bell at any desired pressure and at any distance from the gage.

Thermometers.

As steam at various pressures always has a corresponding temperature a thermometer may be used to determine the pressure in a vessel. For instance, steam at a pressure of 100 pounds above vacuum has a temperature of 327.6 degrees F.; at 150 pounds, a temperature of 358.2 degrees, and at atmospheric pressure, or 14.69 pounds absolute, it is 212 degrees. Knowing the steam pressure desired and the corresponding temperature, the thermometer can be used to designate the pressure being carried.

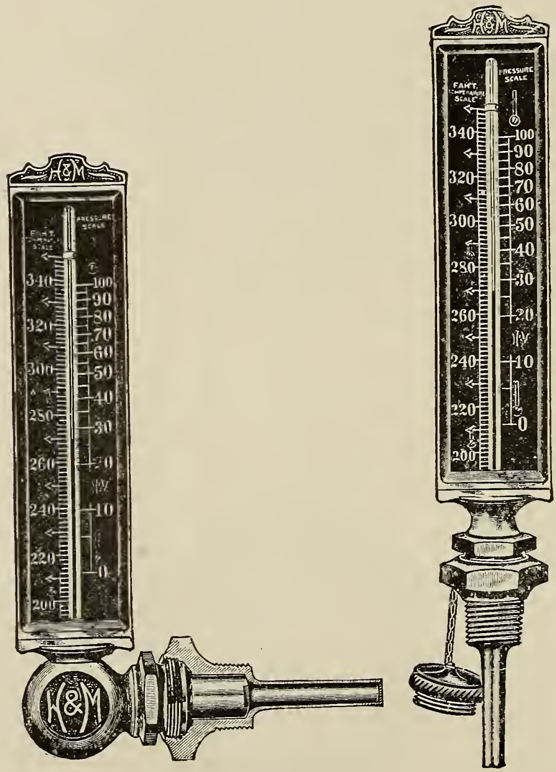


Fig. 356.—The H. & M. Thermometers.

Thermometers are used for both low and high range. The former ranges from 20 degrees F. below to around 220 degrees above zero; the latter from zero to 1,000 degrees F. Thermometers for use with steam are usually made with a temperature and pressure scale as shown.

The straight thermometer shown on the right in Fig. 356 has a separable socket connection and a 12-inch scale with a range 200 to 340 degrees F. and 0 to 100 pounds pressure. It is used on open steam vulcanizers, tire and belt presses. On the left is the right side angle thermometer with separable socket connection. It has the same scale and range as the vertical thermometer and is used on mechanical goods presses. It is conveniently attached to the side of the platen and the face can be turned at any angle. A small fitting called an elevator or steam circulating pocket is sometimes attached to the thermometer for insuring circulation of dry steam around the bulb.

Mercury Cup Thermometer.

If the pressure is low, the thermometer socket is screwed into the vessel or the steam pipe. A steel cup *A* is frequently screwed into the pipe and then partly filled with mercury. Fig. 357. When the temperature is to be taken the thermometer *B* is inserted and as the mercury

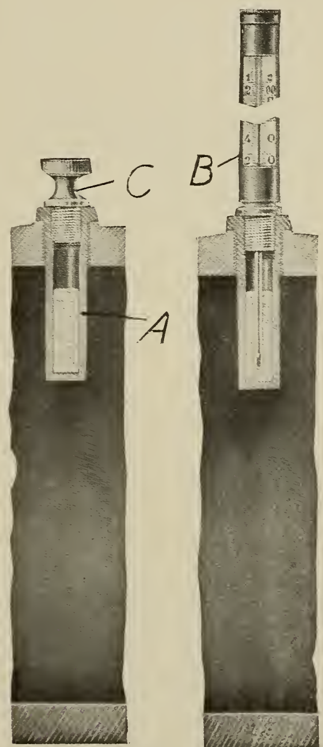


Fig. 357.—Mercury Cup Thermometer.

is of the same temperature as the steam, a correct reading is obtained.

A plug *C*, screwed into the cup when not in use, keeps the mercury clean. The thermometer may also be permanently secured in the cup.

The H. & M. Varnish Thermometer.

The use of thermometers in the manufacture of shoe varnishes has become practicable, with instruments capable of indicating reliably, temperatures ranging from 600 to 1,000 degrees F.

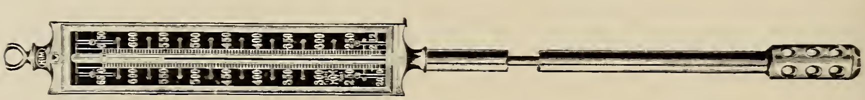


Fig. 358.—The H. & M. Varnish Thermometer.

It is a well known fact that mercury boils at about 676 degrees F. under atmospheric pressure, but when contained in an ordinary glass thermometer tube which is vacuum above the column, ebullition takes place at a lower degree of heat. For this reason ordinary thermometers cannot be used in gum melting, although the scale may indicate much higher than the capacity of the thermometer.

To obtain a thermometer capable of indicating temperatures above the boiling point of mercury, it is necessary to replace the vacuum above the column by pressure; in other words, filling the space with a compressible gas, which, according to the degree the thermometer is intended to register, must be compressed at ordinary temperatures.

The long stem thermometer shown in Fig. 358 is of this type and is used in manufacturing rubber boot and shoe varnishes. They are all made with sliding scales and a scale adjusting device is furnished on order.

The Bristol Recording Thermometers.

As in the case of pressure gages, thermometers are made to record the temperature for each 24-hour duration. Recording thermometers, for example, are made for low and high range. Both depend for their operation on the expansion of a gas contained in a bulb, which is connected by a flexible capillary copper tubing to either a helical or spiral form of pressure tube. Any change in temperature at the bulb causes a change in the pressure of the gas contained in it. This change in pressure is transmitted through the flexible capillary tube to the pressure tube in the thermometer. The recording arm is attached to the pressure tube and records the temperature on the round chart of the instrument.

The Bristol Bulb Attached to Pipe Elbow.

Fig. 359 shows the recording thermometer bulb for measuring the temperature of liquids, steam, gas and air in pipes under pressure.

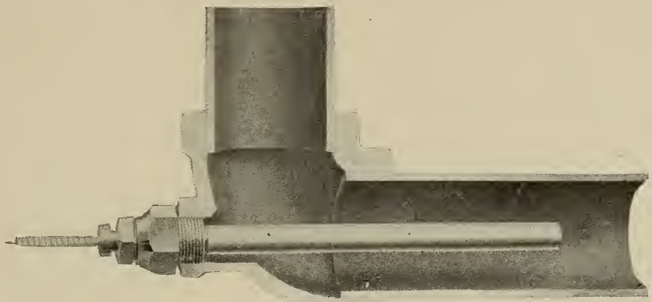


Fig. 359.—The Bristol Bulb Attached to Pipe Elbow.

The Bristol Bulb with Socket.

In Fig. 360 the bulb is shown protected by a socket. This is necessary with superheated steam, condensed water, compressed air and similar applications where the bulb is liable to be injured.

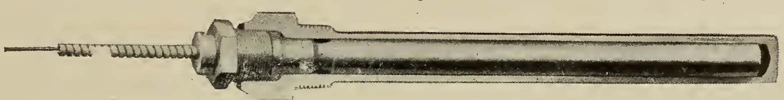


Fig. 360.—The Bristol Bulb with Socket.

The Bristol Helical Tube Recorder.

The mechanism of this recording device is shown in Fig. 361. Changes of temperature at the sensitive bulb cause corresponding changes in the pressure of the gas inside the bulb, and these changes are transmitted through the flexible capillary connecting tube to the helical pressure tube in the recording instrument. The recording pen arm is attached directly to the pressure tube without the use of any multiplying devices, gears, links, levers or other complicated mechanism.

The Bristol Spiral Tube Recorder.

The thermometer shown in Fig. 362 has the spiral form of pressure tube and is used for the higher ranges of temperature, such as 800 or 600 degrees. It has also recently been adapted for the low ranges of temperature, such as atmospheric ranges and refrigeration temperatures. In order to adapt these thermometers for accurately recording low ranges of temperature a special compensating attachment makes these thermometers independent of changes of temperature at the

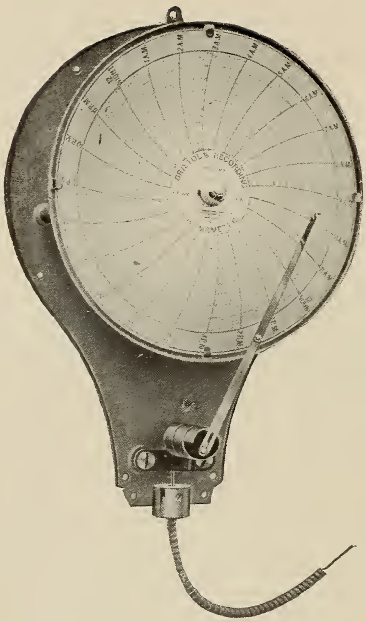


FIG. 361.—HELLICAL RECORDER.

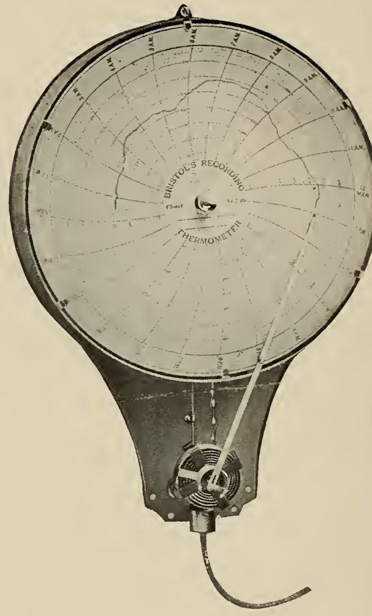


FIG. 362.—SPIRAL TUBE RECORDER.

recording instrument. No multiplying devices are employed. The pen arm is attached direct to the double pressure tube.

The recording thermometer, as in the case of the recording gage, produces an undisputed record of the steam pressure and the temperature carried in the vulcanizer. If the goods are not right when removed and if the fault is due to the temperature, the chart indicates where to look for the difficulty and whom to hold responsible.

The recorder may be placed at a distance of 25 feet from the bulb and thus is easily placed in the foreman's office where the record produced may be under his observation at all times. A chart from a recording thermometer is shown in Fig. 363.

TEMPERATURE ALARM SYSTEM.

An early system of temperature regulation, Fig. 364, consisted of a thermostat, a butterfly steam valve, batteries and a motor. The thermostat *A* fitted with three contacts is attached to the vulcanizer *B*. The central wire is attached to the outside terminal of the motor *C*. The other outside motor wire connects with the battery *D* and the central motor terminal connects with the outside terminal of the thermostat, the other thermostat terminal being connected with the battery.

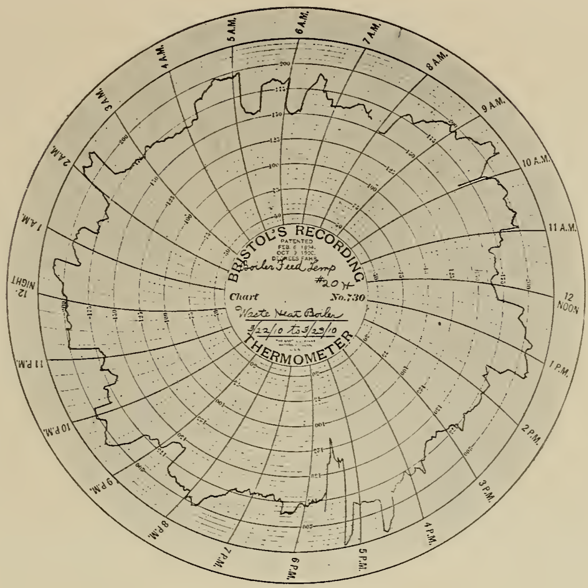


Fig. 363.—Chart Made by Recording Thermometer.

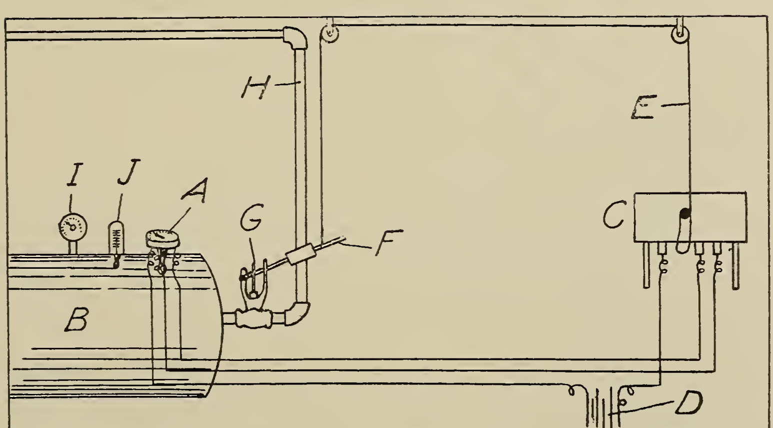


Fig. 364.—Temperature Alarm System.

With a low steam pressure and temperature the contact is made between two terminals of the thermostat, causing the motor to operate in a direction to tighten the cord *E* and lift the weighted lever *F* of the valve *G*. This action admits steam into the vulcanizer through the steam pipe *H*. When the temperature reaches a certain high limit,

contact is made with the other thermostatic terminal, reversing the motor, which loosens the cord *E*. The weight then closes the valve *G*, shutting off the steam supply. Besides the thermostat, the vulcanizer is fitted with a steam gage *I* and thermometer *J*.

Electric Alarm System.

An electric alarm regulator capable of attaching to a vulcanizer is illustrated in Fig. 365, its purpose being to signal to distant points the degrees of temperature. The thermometer *A* is attached to the vulcanizer *B*. Electric connections *C*, *D* and *E* from the mercury column in the thermometer connect with the batteries *F*, switch *G* and the bells *H* and *I*. The electric circuit is affected by the rise and fall of the mercury column. The center connection *E* is at the 140-

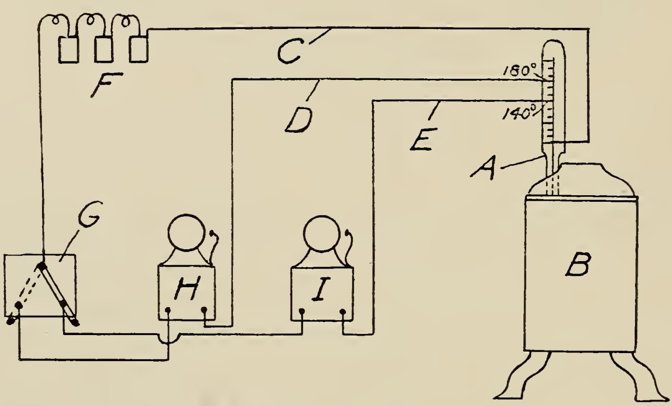


Fig. 365.—Electric Alarm System.

degree graduation, corresponding to about three pounds pressure above vacuum, and connects with the bell *I*. When the temperature in the vulcanizer reaches 140 degrees, the mercury contacts with the wire *E*, forming a circuit through the mercury column, wire *C*, batteries *F*, switch *G*, bell *I* and wire *E* to the mercury, thus completing the circuit and ringing the bell *I*. When this bell rings and it is desired to increase the temperature to 180 degrees, the switch is thrown to the position shown by the dotted lines. Then, when the mercury column reaches the 180-degree graduation, corresponding to about 8 pounds pressure above vacuum, a circuit is formed through the wire *D*, bell *H*, switch *G*, batteries *F* and wire *C* to the mercury column, thus completing the circuit and ringing the bell *H*.

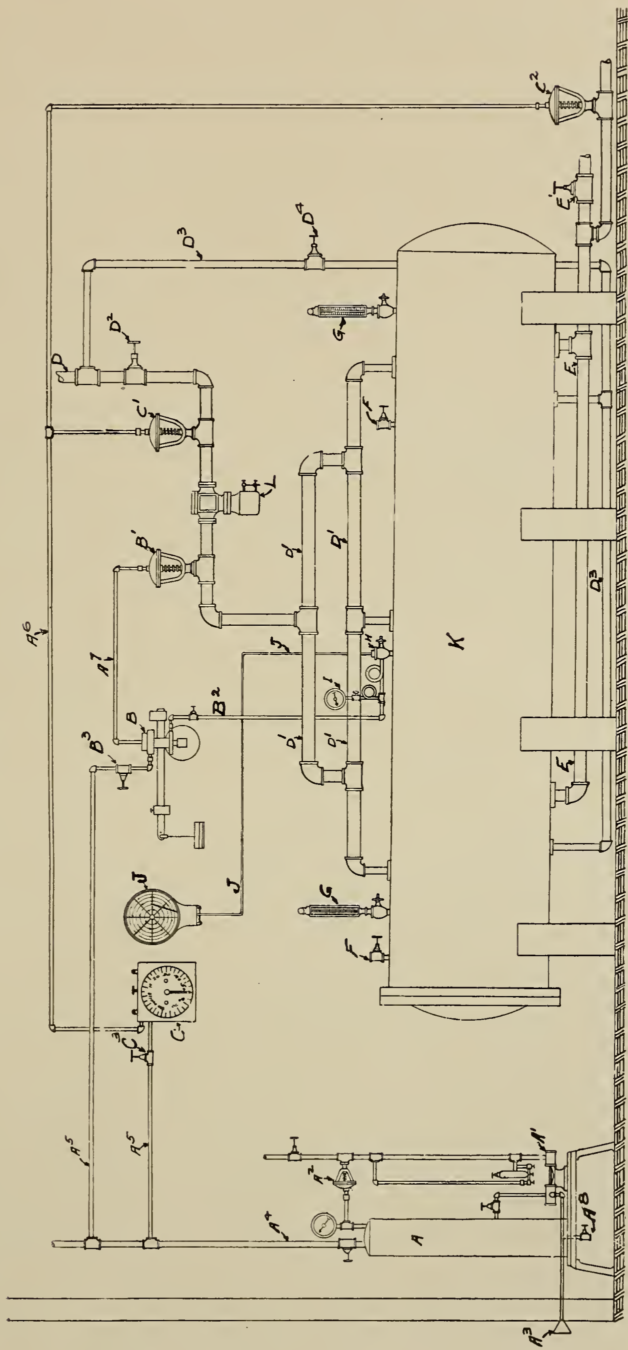


Fig. 366.—The Tagliabue System of Temperature Control.

The Tagliabue System of Temperature Control.

The leading feature of this system is the pressure governor for throttling the steam valve, in accordance with the pressures inside of the vulcanizer or press.

When the governor is set for the desired temperature or pressure and the steam turned on, the heater practically takes care of itself. As there is a definite equivalent in degrees of temperature for every pound of pressure of saturated steam, weights for the governor give control at any desired degree of heat, and as all the observations are made with the thermometer, it is virtually temperature control.

The apparatus shuts off the steam at the expiration of the cure, and if desired also operates a blow-off valve.

Fig. 366 illustrates the arrangement of the system as applied to a vulcanizer. Compressed air is used for operating the controlling valves. The air compressing outfit consists of a small steam air compressor A^1 and air storage tank A, mounted on a stand. The tank is supplied with pressure gage, and from the top is taken the main air supply line A^4, subdividing into the branch lines A^5, supplying the pressure governor B and the time device C. The air pressure required is 15 pounds or more. To maintain this pressure constant the controlling valve A^2 is placed on the steam line to the compressor, and connected to the storage tank. This valve can be adjusted for any required air pressure, and will control the supply of steam to the compressor, so that the desired pressure of air will be maintained with a minimum use of steam. As the amount of air used by each device is small, this compressor will furnish air for quite a number of vulcanizers. The air intake to the compressor is placed out of doors, away from steam vapor or dust. In the bottom of the storage tank is a blow-off valve, A^8, for blowing off at intervals accumulated water and oil.

The pressure governor B is provided with a flange for securing it to the wall near the vulcanizer or press. The lever is hung on knife edges and is as accurate as a scale beam, as it rests on a rubber diaphragm in the circular base. Above the lever is a circular casing, containing the air valves operated by the lever. The base containing the diaphragm is connected to the vulcanizer or press by means of pipe B^2. To the top is connected the air supply pipe A^5 and the air discharge pipe A^7, which latter is connected to diaphragm valve B^1.

The diaphragm valve B^1 is placed on the steam line to the vulcanizer and is of the globe type. On the bonnet is screwed a cast iron frame, in the top of which is secured a rubber diaphragm. The stem

of the valve is sliding, surrounded by a volute spring, and topped with a wooden saucer, resting against the rubber diaphragm. When the latter is actuated it presses against the saucer, which forces down the sliding stem, compresses the spring and closes the valve. When the air discharges, the diaphragm collapses, the steam pressure under the seat of the valve, by the aid of the spring, forces back the stem, and opens the valve..

The pressure governor operates thus: A weight equivalent to the pressure denoting the temperature desired, is placed on the hanger at the end of the lever. Cock B^3 admitting compressed air to the governor is opened, and steam turned into the vulcanizer or press at the hand valve D^2. This is communicated to the diaphragm of the governor, through the pipe B^2, and when the desired pressure has been reached, the diaphragm actuates the lever, which in turn operates the air inlet valve in the upper casing B, permitting the passage of air into the pipe A^7, compressing the diaphragm in steam valve B^1, forcing down the stem and shutting off the steam. When the pressure falls the fractional part of a pound, the governor diaphragm collapses slightly, lowers the lever, closing the air inlet valve, and at the same time opening an air discharge valve, which relieves the steam valve diaphragm of the air pressure causing it to collapse, and permitting the steam valve to open again. During the vulcanizing process the diaphragm steam valve B^1 is rarely wide open or fully closed, for the reason that the governor is so sensitive that the valve responds instantly to the slightest change of pressure.

The clock C and diaphragm steam valves C^1 and C^2 constitute the time device of the system. The valve C^1 is on the steam supply line to the heater, and when actuated by the clock, it opens and blows out steam.

Compressed air is supplied by pipe A^5 and connected with valves C^1 and C^2 by A^6 operating as follows: Air cock C^3 is opened admitting air to the pneumatic valve of the clock, the hand is set for the time required for the cure. The hand travels to the left, and at the expiration of the time, it will trip the lever of the pneumatic valve, and thus turn on air into pipe A^6, which will operate the diaphragms of valves C^1 and C^2, thereby shutting off and blowing out the steam, so that without the necessity of handling any valves, the heater may be opened and the goods taken out. The operation of the clock is independent of that of the governor.

Besides showing the application of the pressure governor and time device, the diagram illustrates the Tagliabue plan of piping for

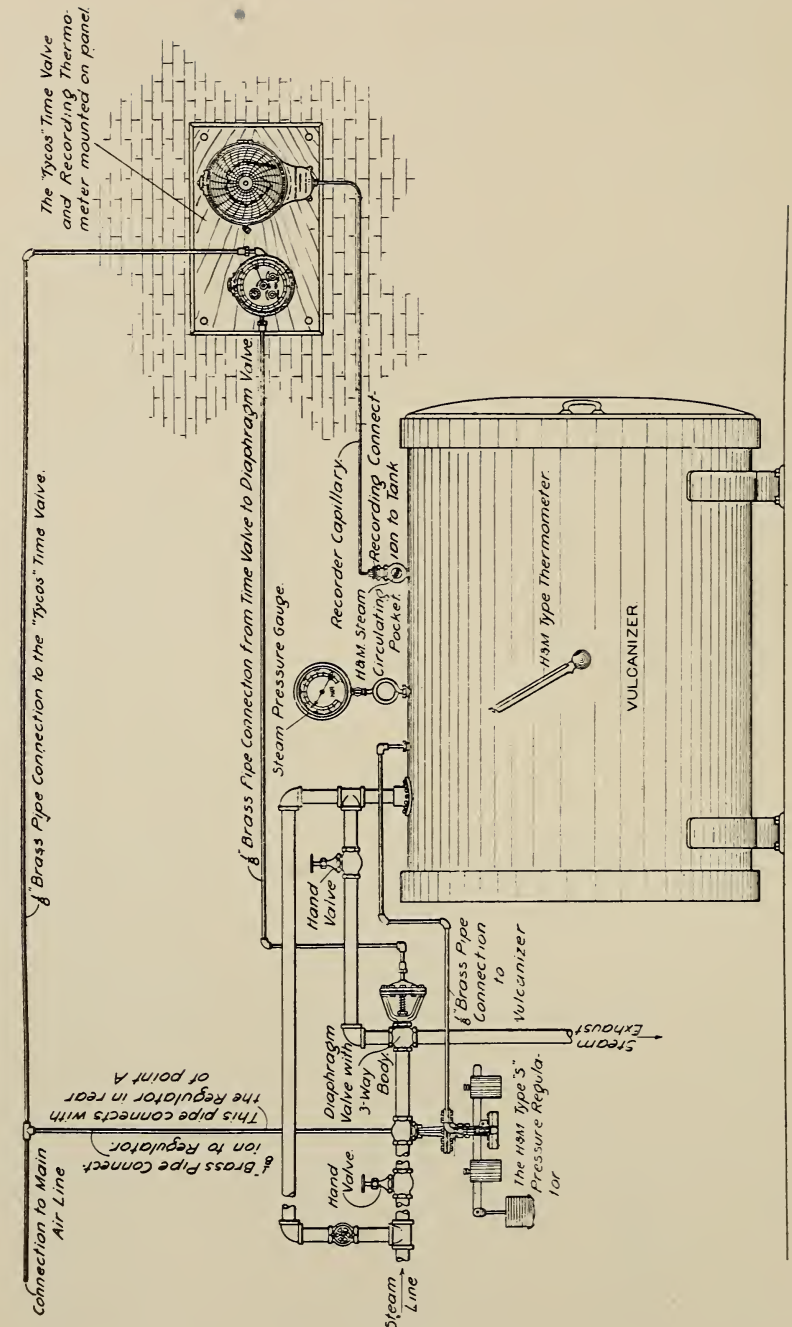


FIG. 357.—THE TYCOS SYSTEM OF TEMPERATURE CONTROL.

a hose vulcanizer, with the necessary fittings and their location. D represents the steam supply from boiler, and D^1 D^1 D^1 D^1 the 2-inch steam supply to the vulcanizer with three 1-inch inlets. This supply is so piped as to give an equal volume of steam to each of three inlets. D^3 represents 1-inch steam supply to the bottom with two inlets, and E E discharge pipe. F F represents the air blow-off valves, which are 1¼ inches to vent the air quickly.

G G are the mercury thermometers, screwed into special fittings. H is a similar fitting for a recording thermometer. This is provided with a steam circulation cock, also with an opening for attaching a steam gage and pressure governor connection. I is the ordinary spring pressure gage. J J represents the recording thermometer with its connecting tube, which can be 25 or more feet in length. K is the vulcanizer and L the steam separator.

The Tycos System of Temperature Control.

Fig. 367 illustrates the H and M system of automatic heat regulation applied to a vulcanizer. It shows the application of the type "S" regulator, "Tycos" recording thermometer "Tycos" time valve for timing the length of cure and the H and M right side angle thermometer.

The Tycos Time Valve.

This device is attached to the press or vulcanizer and allows the cure to run exactly the right length of time. Then it automatically shuts off the steam and opens the blow-off. The valve is operated by compressed air and can be made to operate 20 minutes, 2 hours, 4 hours or 24 hours.

The Ellinwood-Seiberling Vulcanizer Control.

The machine shown in Fig. 368 is designed for accurately timing the curing process and for automatically shutting off the steam and opening the molds at a predetermined time by a clock mechanism. Referring to the two drawings, A represents the apparatus with the molds open and B shows the regulating device in the position it assumes when the molds are closed.

The shaft C, bearing a grooved pulley D, is turned one revolution an hour by a clock mechanism (not shown here). The driving shaft E is driven by a belt and turns at a faster speed than the shaft C. These two shafts may be extended to operate any number of vulcanizer molds simultaneously. The lower half F of the mold rests upon the frame of the machine and the upper half F^1 is hinged by hollow jour

nals *G*, which also serve to admit steam for vulcanization. The upper part F^1 is counter-balanced by a weight *H*. In operation, the two shafts *C* and *E*, being set in motion by the clock mechanism and the driving belt respectively, and the press molds being open as shown, the unvulcanized tire is placed in the lower mold and inflated with live steam. The operator then disengages the hook on the end of the connecting rod *I* from the pin on the lever *J*, and pushes the lever *J* to the right, opening a three-way valve *K* and admitting steam to the molds. The lever *J* is thrown back until the hook from the rod *I* again drops over the pin on the lever. The operator pulls the starting rod *L* to the left, causing the driving shaft *E* to rotate. The four-way valve *R* is opened to admit water above the piston in the hydraulic cylinder R^1. As the piston descends the upper part F^1 of the mold descends by gravity. The lever *S* draws in the upper end of the clamp arm *T* down over the top of the mold. As the piston continues to

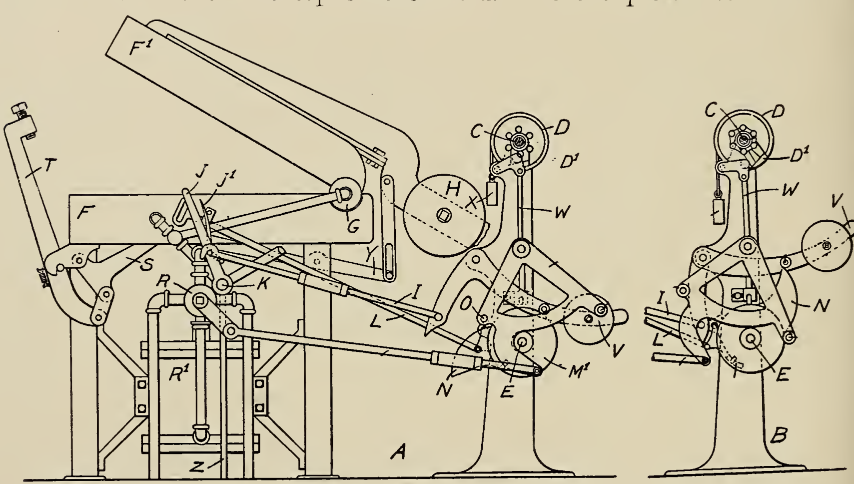


Fig. 368.—The Ellinwood-Seiberling Vulcanizer Control.

descend, the toggle-joint action forces the molds together. As the molds are clamped together the steam valve *K* opens and live steam is admitted to the molds. When the revolution of the wheel bearing the wing-cam *N* has reached this position its motion is arrested for a definite time to allow the process of vulcanization to be completed.

Attached to the face of the grooved pulley *D* is a wedge block D^1 which raises the rod *W* and engages the ratchet wheel M^1. The face of the pulley is graduated and the wedge block may be adjusted to raise the rod *W* after any desired number of minutes up to one hour. The levers remain in the position shown at *B* during vulcanization.

When the cure is complete the weighted lever V descends and forces the rod I and the lever J to the left, thus closing the steam inlet and allowing the escape of steam through the exhaust pipe Z. Water under pressure is admitted to the cylinder R^1 and forces the piston up. This also disengages the clamp arm T from the molds. The cross-head on the upper end of the piston rod forces the lever Y down and opens the molds by assistance of the counterweight H.

The time during which the molds are closed for vulcanization can be arranged for any kind of rubber goods, and the time-shaft automatically controls the time of vulcanization without attention on the part of the operator after the molds are closed.

CHAPTER XX.

RUBBER LABORATORY EQUIPMENT.

THE laboratory is today a most important adjunct to the well equipped rubber factory. All crude rubber compounding ingredients and fabrics, as well as lubricating oils, fuels and general supplies, are these tested. In its various departments, routine, physical, mechanical, electrical and experimental, it is the brain of the factory.

There is probably no industry in which scientific control by chemical and physical tests and analyses is of equal importance. The raw material—India rubber—is produced from various plants, gathered and coagulated in many different ways. It contains, besides rubber, resins, insoluble matter, nitrogen, ash, water and added impurities or preservative substances.

Crude rubber is usually bought and sold without previous determination by chemical analyses of the percentages of the various substances present which affect the value of the raw product. It is probable, however, that it will eventually be sold on a known analysis as are coal, silk, iron ore, sugar, copper and nearly all other raw products.

India rubber, although consisting essentially of the hydrocarbon of the formula $C_{10} H_{16}$, has three different constituents, the soluble hydrocarbon, the insoluble part or "nerve," due to a nitrogenous body, and the resin.

By chemical tests, therefore, the varying amounts of rubber, the resins and the insoluble "nerve" containing the nitrogen, can be determined. The shrinkage also, consisting of the water and dirt, can be determined by washing. It is impossible to estimate by inspection the amount of water, dirt, etc., in rubber, to within 3 per cent., while it can be determined by analysis to less than one per cent. Two per cent. saved on all crude rubber bought would materially add to the profits of the works.

Analysis and general physical examination of vulcanized rubber is of the greatest value. To determine the character and quality of rubber contents by a complete chemical analysis and physical examina-

tion is a difficult and tedious process, yet the total rubber, the earthy and oily fillers, the free and combined sulphur, the fabric and the resins can be shown in most cases by a few physical tests and the determination of the principal chemical constituents.

Testing Crude Rubber.

In testing, it is necessary to get a small sample representative of the mass. Nothing is more heterogeneous than crude wild rubber, and getting an accurate sample is therefore difficult and requires care.

The chemist begins with the rubber as it arrives at the factory in biscuits, balls, slabs, crepe, etc. In taking a sample many representative pieces must be cut through and slices taken to get proportional inner and outer parts, which will vary greatly in moisture content and perhaps in other constituents. Really, from 10 to 20 pounds should be taken for the washing test. The sample should be preserved in an air-tight container so that no moisture can evaporate.

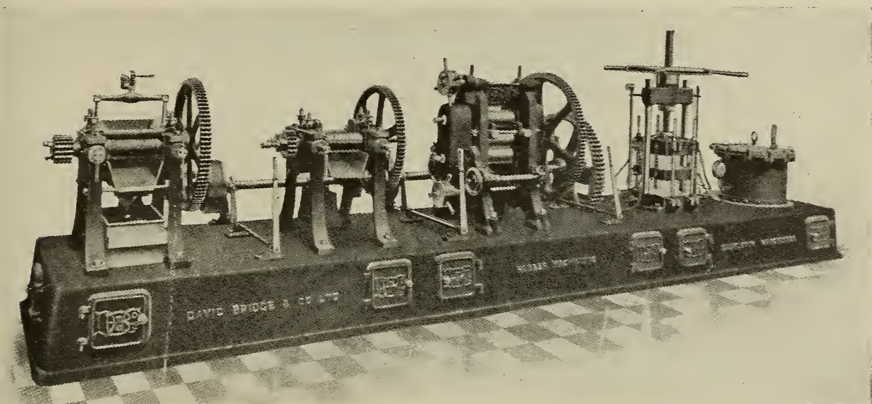


Fig. 369.—Miniature Washer, Mixer, Calender, Press and Vulcanizer.

The whole sample, or a large part of it, should be weighed before washing, and preferably the metric weights used. After weighing it is sometimes advisable to soften the rubber by heating in water, but this should not be boiling hot.

Factory washing is described in Chapter I and will serve as a guide except that a miniature washer is used. A tank is also advisable, so that the dirt can be examined.

Laboratory Rubber Machinery.

Experimental work is done on the miniature machines illustrated in Fig. 369.

These are a washer, mixer and calender, driven by an electric motor, together with a vulcanizing press and a vertical vulcanizer.

The washing consists in repeatedly passing the rubber between the corrugated rolls of the washer. A constant shower of water is directed on the rubber, washing out the impurities. Not only is the dirt removed but also soluble substances, such as organic acids, the product of fermentation, or substances added to effect coagulation.

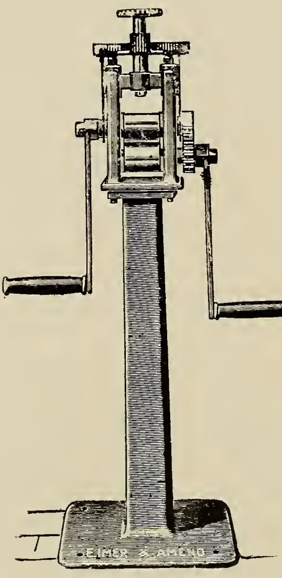


Fig. 370.—Hand Rolls for Washing.

Hand Rolls for Washing.

For the commercial chemist who has only a few determinations to make and is not equipped with rubber washers, it is possible to wash on the hand rolls shown in Fig. 370.

Cylindrical Vacuum Dryer.

After washing the rubber is dried in warm air or in a vacuum dryer. Drying is treated comprehensively in Chapter II and may be referred to for guidance in drying test samples.

The vacuum dryer, shown in Fig. 371, is a cylinder supported on an angle frame encased in Russia iron and heated by gas or steam.

The shell is made of seamless drawn heavy brass tubing, jacketed, with 1-inch steam space. The swing door has a ground joint

flanged face and a rubber gasket, and is fastened by wing nuts, ensuring a perfect air-tight joint. The oven, 16 inches long and 8 inches in diameter, is tinned inside and provided with two perforated trays. Above and below these trays, at the back of the oven, are two 1/4-inch perforated brass pipes, plugged on their inner ends, which may be used to moisten the material within the oven. The oven is equipped with two perforated pipe burners which may be used for gas heating, also an adjustable constant level arrangement for the water in the jacket. For steam heating a suitable nipple connection is provided,

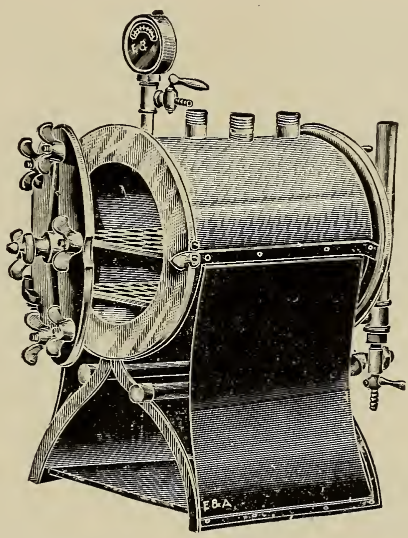


FIG. 371.—CYLINDRICAL VACUUM DRYER.

and in the bottom a drip-cock draw-off for the condensed steam, also a stop cock to close connection with the constant level arrangement. There are also provided openings for exhausting air and moisture from the chamber, for thermometer, vacuum gage, etc.

THE FREAS VACUUM OVEN.

The advantages of constant temperature apparatus for chemical research and industrial processes are being recognized more and more, especially since the advent of the Freas method of electric temperature control, insulation, etc. (allowing for continuous unattended operation) as employed in the oven illustrated in Fig. 372.

This apparatus consists of a rectangular constant temperature electric oven, with cast bronze vacuum chamber properly supported inside the oven, fitted with connections for vacuum and passing in a stream of hydrogen or other reducing gases. The body of the chamber is square, with rounded corners. The front, on which the door fits, is cast circular and is heavily reinforced, as is the door, to give a substantial bearing surface which produces a perfect vacuum-tight connection. The door can be rotated in a swivel holder which swings on the hinges. This permits of these bearing surfaces being easily and accurately ground in case of need. The central part of the door

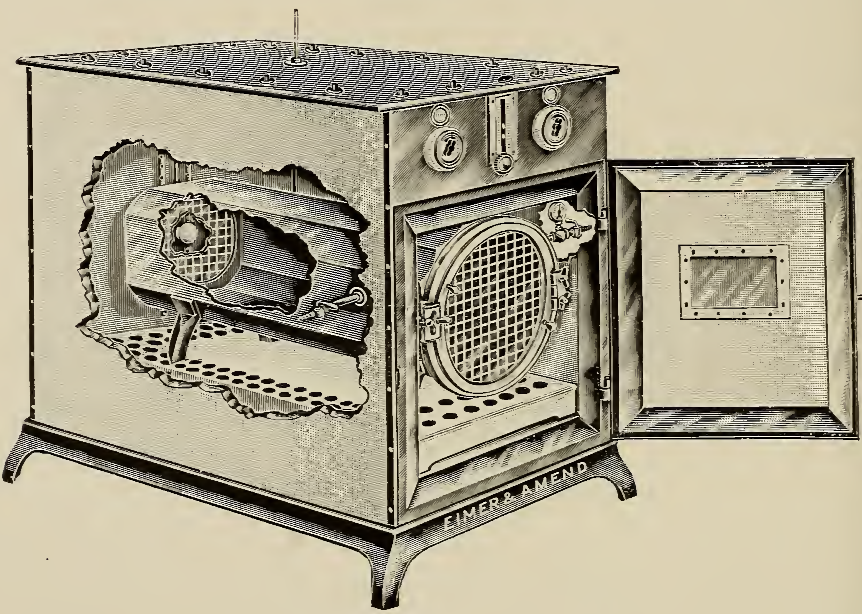


FIG. 372.—THE FREAS VACUUM OVEN.

and the back of the chamber are covered with metal screens, on which rest mica plates made vacuum-tight with the frame. This permits inspection of the chamber by means of the electric lamp at the back of the oven beyond the vacuum chamber. The vacuum chamber is provided with cast ribs on the sides to accommodate up to 10 shelves. Inside dimensions of the vacuum chamber, 8x8x18 inches. Temperature range, up to 180° C., or higher is desired.

VACUUM DRYER WITH CONDENSER.

The apparatus shown in Fig. 373 has a drying cylinder *A* 15 inches high and 18 inches long, with about 2 square feet of pan surface.

The cylinder has a steam inlet *B*, outlet *C*, vapor pipe *D*, vacuum regulator *E*, thermometer *F*, vacuum gage *G* and vent pipe *H*. The vapor pipe passes through a surface condenser *I*, which has a water inlet *K* and an overflow *L*. The condensation is collected in the tank

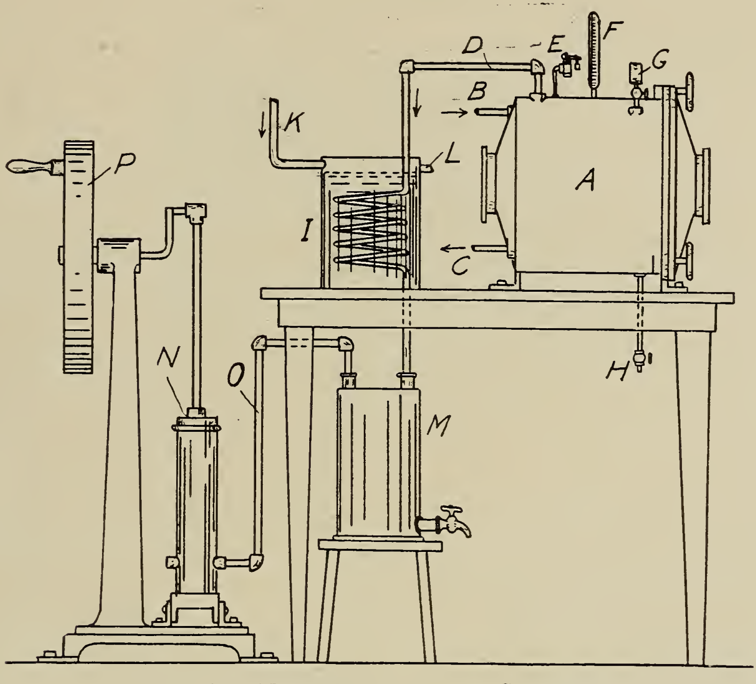


Fig 373.—Vacuum Dryer with Condenser.

M. The vacuum is created by a pump *N* connected with the apparatus through a suction pipe *O*. The pump may be power driven or operated by the hand wheel *P*.

Vacuum Shelf Dryer.

Referring to Fig. 374, the column *A* covers the condenser, while base *B* contains a compartment for the condensed vapors. The vacuum chamber *D* is jacketed for steam, hot water or gas. The drying compartment *E* is large enough to take a pan or tray 18 inches square. The door *F* is locked by levers *G* engaging lugs *H* on the ends of the door. The progress of the drying is observed through glass windows *K* in the door. The apparatus is frequently employed to determine

the size of dryer to use for a given piece of work, the depth and amount to load the pans per square foot, etc. The results obtained with this apparatus per square foot of pan surface can be duplicated in any

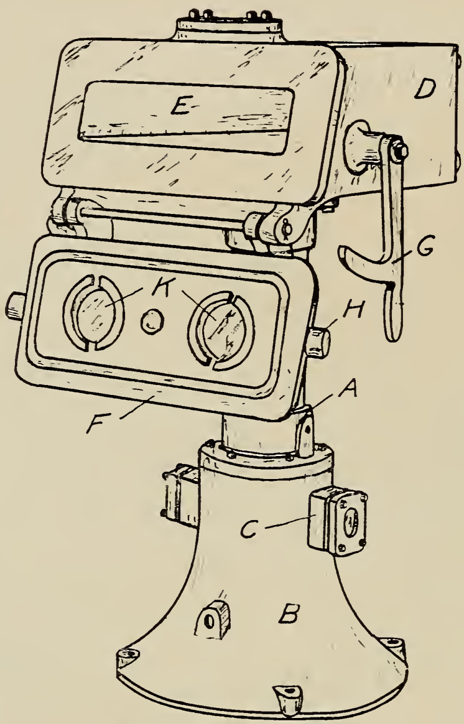


Fig. 374.—Vacuum Shelf Dryer.

larger shelf dryer operating upon the same principle and under the same conditions.

The Sargent Electric Oven.

The oven illustrated in Fig. 375 is heated and automatically controlled by electricity. It may be set for any temperature between 60° C. and 150° C. The oven consists of an asbestos lined box bound with metal, 12x10x10 inches in size. The two upper shelves are for constant temperature work and the bottom one for inorganic work at high temperatures. The heating units are in the lower part of the box, which has a mica-covered window for observing the glowing wires. The temperature is raised or lowered by the insulated milled head at

the left of the window. A similar head on the left of the oven operates a device which maintains the heat controlling device in the position in which it is set. The openings at the top are for a thermometer and ventilation. The oven operates on either direct or alternating current and a 6-foot cord socket plug and a thermometer are furnished with the oven.

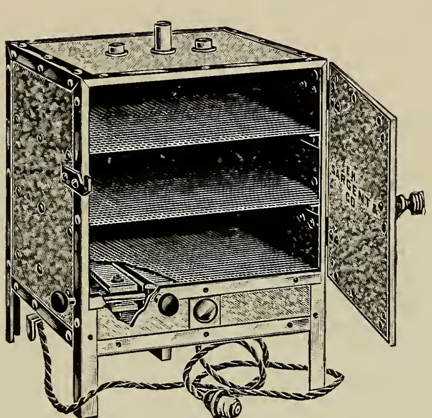


FIG. 375.—THE SARGENT ELECTRIC OVEN.

THE CENTRIFUGAL SEPARATOR.

In separating the insoluble constituent of the rubber and in eliminating impurities such as small particles of bark, sand, etc., a centrifugal separator is used.

A solution of the desired strength is made up with a solvent for the rubber and placed in a test tube fitted into containers. After spinning, all insoluble matter will have settled to the bottom of the tube. Larger quantities may also be treated in the larger holders.

INTERNATIONAL ELECTRIC CENTRIFUGE.

The well known electric centrifuge, illustrated in Fig. 376, is in use in many rubber laboratories. As indicated in the cut, containers of several sizes and shapes may be used. The 8-place combination head or carrier shown has places for 2 flat-bottom trunnion cups, in which can be placed bottles of 250cc. capacity, and places for 6 other tubes of varying lengths and diameters from 15cc. to 100cc. capacity each. Squibbs separatory funnels of 150cc. capacity may be used in the two larger places.

This machine stands about 28 inches high and is about 24 inches in diameter. The electric motor is built into the base and is specially

designed both mechanically and electrically for efficient service. A brake is provided to save time in routine work, and a device connected with the brake allows the machine to slow down very gradually at the end so as to avoid stirring up fine and light precipitates. A rheostat is furnished by which the speed may be controlled within wide limits.

With many of the rubber compounds the density of the precipitate is little different from that of the liquid. A high centrifugal force

FIG. 376.—INTERNATIONAL ELECTRIC CENTRIFUGE.

is therefore required for efficient precipitation, and this is provided by the high speed and large diameter of this centrifuge.

A very considerable variety of other equipment than that above described can be furnished with this centrifuge.

When the sample is dry it is weighed. The weighing of both wet and dry samples is done on an apothecary's scale having metric weights.

The washing and drying not only determines the loss or shrinkage but so masses the sample that it is nearly uniform, and laboratory samples can be taken from it. Crude rubber cannot be ground or shredded easily, so that cutting with scissors is the best way to obtain fine pieces. Having determined the factory loss by an imitation of factory methods, the chemical analysis proper is begun. The weighing of, say 5 grams, must be done on a chemical balance.

Scales and Balances.

The success of chemistry has been due, more than all else, to the use of accurate weights and measures and keeping careful, written

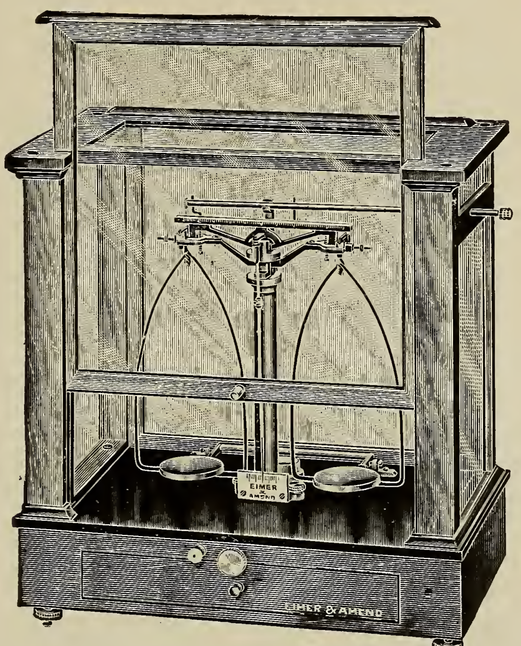


Fig. 377.—Analytical Balance.

records. Too much detail will distract the attention from the main issue, but taking notes during an experiment is a real relief to the mind, and pays in the long run.

The question of weights is of the utmost importance. The use of liquid measures has been very generally abandoned in favor of weighing, as being more accurate. Balances are true, however, only within a comparatively small range; but by means of the wonderful series of weighing apparatus now on the market, it is possible to weigh anything, from a steamship to a pencil mark.

There are many types of balances for fine weighing. One, for example, is so delicate that it indicates a difference in weight of one five-hundredth of a milligram, or less than one fourteenth-millionth of an ounce. For such balances there is furnished a unit-weight, weighing 29.1666 grams; so that in quantitative analysis, on the basis of this unit, each milligram represents one troy ounce per avoirdupois short ton. The bearings in these balances are agate planes, resting upon agate knife edges.

The analytical balance, illustrated in Fig. 377, has a capacity up to 100 grammes in each pan, and is sensitive to one-twentieth of a milligram. It is provided with a short beam, graduated on both sides of the centre agate for a 6-milligram rider, the beam blackened and graduations filled in white, which greatly facilitates the readings. It has agate knife edges and bearings with improved hangers and triple arrest, raising the hangers from knife edges as well as the beam. The wide pans and bows accommodate a dish 10 cm. in diameter. There is an improved arrest for pans with automatic stop and red graduations on the index enabling close readings. It has a finely polished mahogany and glass case with leveling screws and counter-poised sliding door, mounted on heavy black glass sub-base.

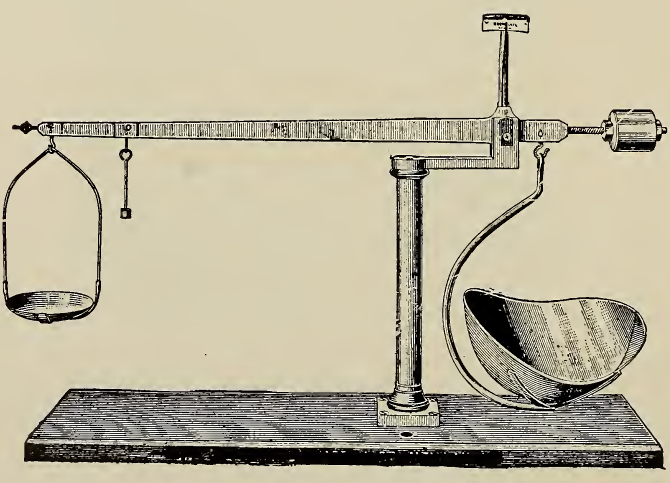


Fig. 378.—Counting Scale.

Fig. 378 shows the multiplying scale, for use in counting small articles of the same kind. This has a capacity of four pounds, and is sensitive to one two-hundredth of an ounce. They are usually made

to count by tens or dozens, though larger multiples could be supplied to order. In using, a dozen of the articles, laid on the long arm, will just balance a gross of the articles on the short beam.

Rubber chemists have always been accustomed to test the specific gravity of rubber samples. For this purpose there are special hydrostatic scales, for weighing in water. There is a sample balance of this type, and also a combination balance, which can be used for ordinary weighing as well as weighing in water. This combination is an all around useful balance, having a capacity of one kilo, and sensitive to one-half centigram. Some of the finer balances, sensitive to one-twentieth milligram, have also an apparatus for taking specific gravity.

For weighing cloth, or sheeted material of uniform thickness, there are balances provided with a cutter to take out a small unit square, so that the indicator gives the weight of a square yard without the necessity of calculation.

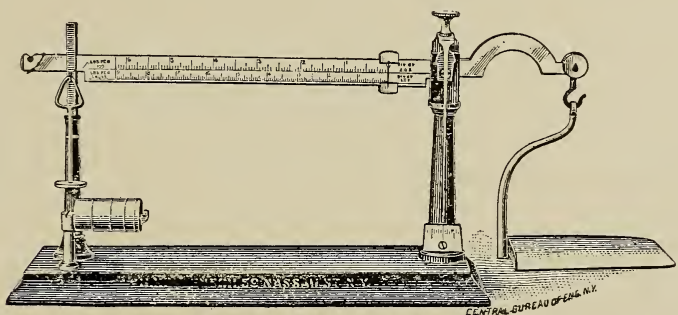


Fig. 379.—Manufacturers' Estimator.

There is a type of balance called an estimator, very convenient for rubber compounding. This is illustrated in Fig. 379. When a small amount of compound is weighed, the indicator will show, at the time, exactly how much of the material will be needed to make a batch of rubber for any desired weight or number of similar articles, and this with greater accuracy than can usually be done by figuring.

When balances are occasionally moved, it is best to have them fitted with screw feet and a spirit level, so that they can be trued up for any table or counter. The hangings are of aluminum, for lightness, and the metal parts should be of platinum, brass, or otherwise made non-corrosive. It is best to have the whole enclosed in

a glass case, to exclude dust, and to keep the metal parts at an even temperature. Very fine readings must be done with a magnifying glass.

Usually a set of weights goes with each balance, but these can always be found in the general market, too, ranging from a milligram (about one twenty-eight-thousandth of an ounce) to 50 pounds. The metal of these must be non-corrosive, since corrosion increases their weight and destroys their accuracy.

Extraction Apparatus.

Different organic compounds are soluble in different volatile solvents, and this is taken advantage of in many processes. Where the sample is subjected to washing by a volatile solvent which is continually re-distilled from the dissolved portion and applied again to the substance examined, the process is called Soxhlet extraction. This is probably the most important process used in rubber analysis. The resins are soluble in alcohol, acetone, methyl and ethyl acetates, which are water soluble solvents. Crude rubber is soluble in benzol, gasoline, chloroform, and many other water insoluble solvents. The inorganic dirt is insoluble in all these. Thoroughly vulcanized rubber is insoluble in everything which does not decompose it.

Vulcanized rubber is, however, soluble in volatile solvents which will not dissolve or destroy the inorganic fillers or the fabric. Some of these solvents dissolve the vulcanized rubber and the combined sulphur. The free sulphur is easily removed with acetone.

Moreover, the pectous rubber or the "nerve" can be separated by extracting out the soluble hydrocarbon with a petroleum fraction at reduced temperatures. It will thus be seen that this extraction with volatile solvents is useful for many separations in the rubber analysis. In reclaimed rubbers which have been properly vulcanized, as much as 25 per cent. of the rubber can be extracted with chloroform after the acetone extraction.

Soxhlet Extraction.

Soxhlet extraction with both hot and cold solvents is therefore the main reliance in rubber analysis. The original Soxhlet apparatus, illustrated in Fig. 380, consists of a set of 6 extractors and water bath, heated by gas or hot water. The flask at the bottom holds the volatile solvent, which is continually distilled by the heat. Above this is the extractor tube, with a side tube leading the vapors to the top, and a small siphon tube for emptying the extractor when it becomes flooded. Above the extractor tube is the condenser, consisting of a

bulbed tube inside a larger one through which water flows. The sample is supported on a wad of cotton or in a paper tube with cloth tied over the bottom and placed in the extractor tube below the condenser so that the condensed solvent will fall on it. The volatile liquid in the flask vaporizes and passes into the extractor tube at the bottom, thence through the side tube to the top of extractor tube, thence up into the condenser, where it is condensed and falls down on the sample in the extractor tube. The soluble parts are dissolved and carried to the flask at the bottom, where the solvent is again distilled

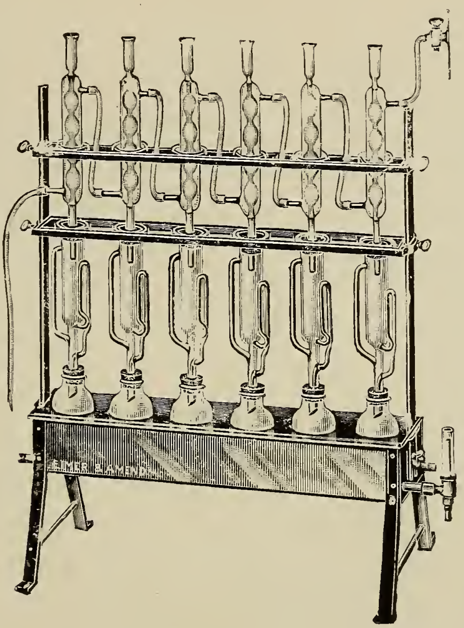


FIG. 380.—SOXHLET EXTRACTORS.

off, leaving the extracted substance in the flask. When the solvent remains clear the extraction is complete. With proper regulation of the heat the operation is constant and automatic.

The sample is then removed from the extractor, dried and weighed. The loss represents the soluble part. If the flask is disconnected and kept on the bath until dry, and then weighed, the increase of weight is the substance dissolved and should check with the other weighing. Of course the sample and flask are both weighed before analysis.

For rubber work this apparatus is objectionable, for several reasons. First, rubber stoppers are, of course, inadmissible, so that cork must be used, and this is seldom tight and frequently contains substances removed by the solvents. Secondly, the substance is kept comparatively cold while being extracted, while hot solvents are neces-

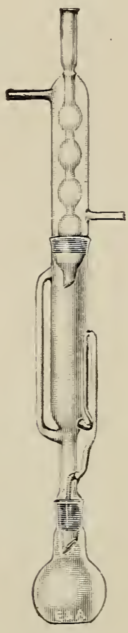


FIG. 381.
EXTRACTOR WITH GROUND JOINTS.

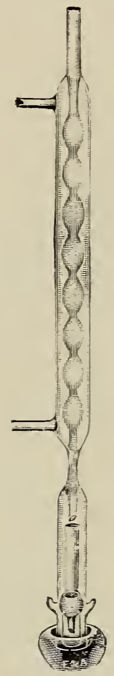


FIG. 382.
EXTRACTOR WITH MERCURY SEAL.

sary in many rubber analyses. To avoid stoppers, ground joints are sometimes used, as shown in Fig. 381, and mercury seals are employed, as shown in Fig. 382. The latter is the Knorr flask, which has a depression around the neck to receive mercury.

Dr. Wiley developed the extractor shown in Fig. 383. This was modified by Ford as shown in Fig. 384.* Here, the idea is to have the large test tube in which hangs the condenser and extractor tube. The Wiley condenser is made of metal while the Ford modification is of glass.

*See "Journal of the American Chemical Society," April, 1912.

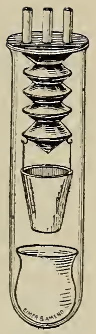


Fig. 383.
Wiley Extractor.

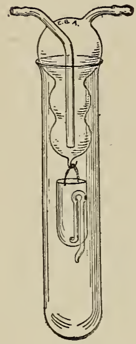


Fig. 384.
Ford Extractor.

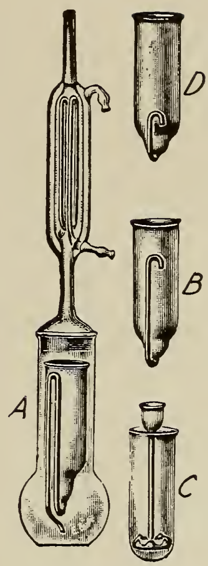


Fig. 385.
Landsiedl Extractor.

An extractor which has many good points is the Landsiedl, shown in Fig. 385. This has only one ground joint. The apparatus is all glass and the extraction tube extends down into the neck of the flask and is kept heated. Several different extraction tubes are furnished—*A* and *B*, used for solids; *C*, used for liquids heavier than the solvent (the solvent flowing over), and *D* for solvents heavier than the liquid examined, the solvent percolating down through the liquid and arising from the bottom through the siphon.

The Bailey-Walker Apparatus.

The extractor shown on the right in Fig. 386 is equipped with a modified form of metallic condenser having a large condensing surface, which has proven entirely satisfactory when used with ether, even in the warmest climate. It has the following advantages: An inexpensive, durable and efficient condenser, which may be adapted to practically any form of continuous extraction apparatus; the elimination of all rubber, corks, ground glass or mercury seal connections; extractions may be safely run over night, since there is practically no danger of breakage due to change in water pressure; the flask is light enough to be accurately weighed; and it is easily cleaned and of such form that all of the extract can be transferred.

The illustration on the left shows a convenient and compact manner of connecting the condensers with water supply and waste pipe. The small tube entering the inlet tube of the condenser should be of copper preferably, and one-eighth of an inch in outside diameter. The iron pipe which receives the outlet tube should be three-quarters of an inch in diameter and of such height that the bottom of the condenser will not touch the heating plate when the flask is removed. The

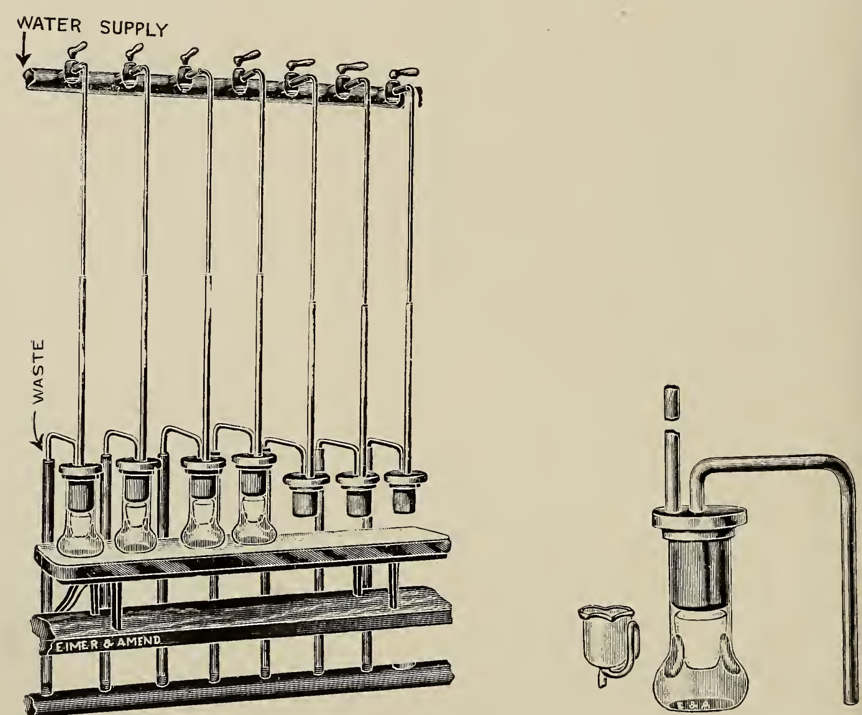


Fig 386.—The Bailey-Walker Apparatus.

apparatus is compact; seven of them can easily be accommodated on an electric hot plate 24x4½ inches. If this type of plate is used it should be fitted with three heats, the high heat so arranged that it will ignite ether.

Underwriters' Extraction Apparatus.

Of late there has come into prominence what is known as the "Underwriters' Extractor," a slight modification of which is shown in Fig. 387. This is the standard adopted by the analysis section of

the Joint Rubber Insulating Committee.* It is easily seen that this is a development of the Wiley extractor, in that the condenser is of metal projecting into the flask. Only two criticisms need be made of this extractor. First, the metal condenser may be acted upon by

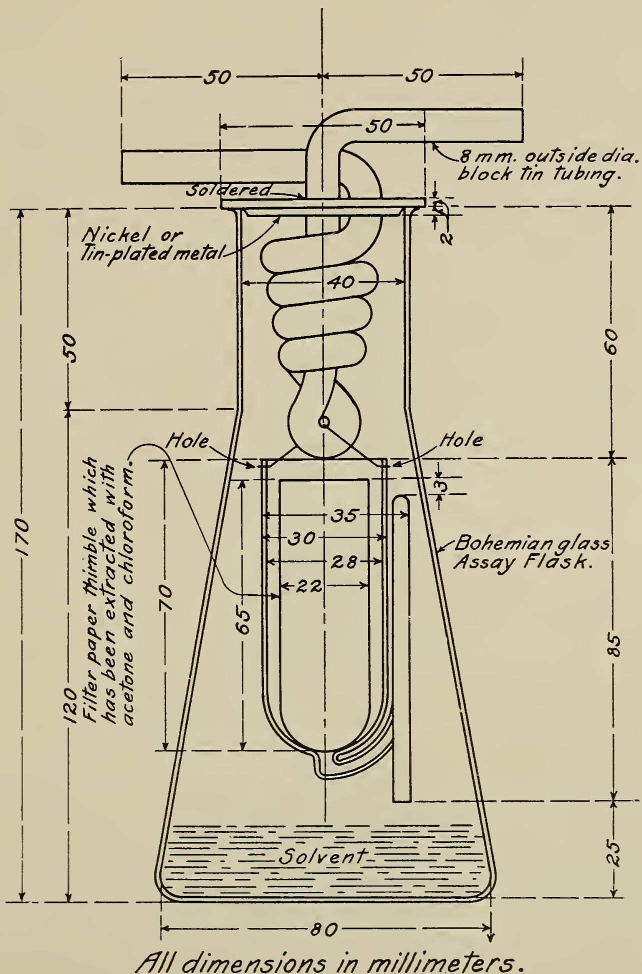


FIG. 387.—UNDERWRITERS' EXTRACTION APPARATUS.

some solvents, particularly the chlorinated compounds. Second, there is apt to be an escape of vapors through the cork or lid. It would appear that there would be an advantage in having the lid of the

*See "Journal of Industrial and Engineering Chemistry," January, 1914.

underwriters' extractor made in hollow stopper form. The condenser might also be made of twisted glass tubing without great difficulty.

In the analysis of crude rubbers an extraction of the dried rubber with acetone is of importance, to determine the amount of resin. Next, an extraction with a certain petroleum fraction under correct temperature conditions gives the amount of pectous rubber or "nerve."

Electrically Heated Apparatus.

Sargent's apparatus, shown in Fig. 388, will accommodate almost any style of glass extractors, all necessity for sliding the corks on

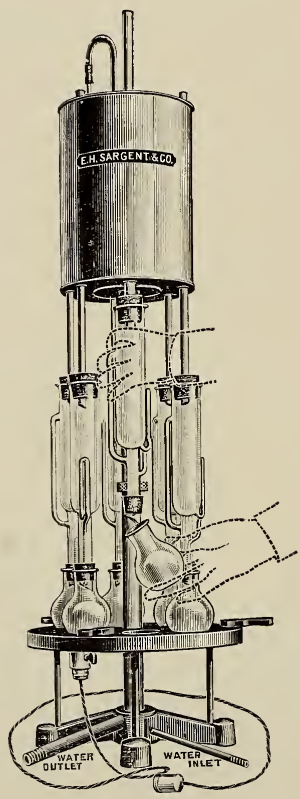


Fig. 388.—The Sargent Electrically Heated Apparatus.

the tubes in order to remove any part of the glassware being obviated. The condensing tube itself slides easily through the cooling tank, enabling any flask or extractor, or both, to be removed from the cork and not the cork from the glass parts as in other forms of support.

As there are no valves or washers used, it is impossible for the cooling tank to leak where the tubes pass through. The water enters at the bottom, passes up through the center column and is carried down to the bottom of the condenser, the warmer water rising by gravity and overflowing. It passes down again through the center column and is voided on the opposite side of the base, making only one inlet and outlet necessary and doing away with the mass of rubber-jointed individual condensers, with their clamps, heretofore used.

The center column is elastic and may be adjusted to suit different lengths of extractors. The minimum distance obtainable between bottom of the tank and the hot plate is 15 inches, the maximum 24 inches. It is always best to adjust the height of the tank in such a way that when everything is in place only one inch of the condensing tube appears above the tank.

Multiple Unit Electric Heater.

The wide application of electrically heated hot plates has disclosed the necessity for temperatures higher than those heretofore attained, but with less expenditure of current and quick replacement of heating units for emergency repairs. The Multiple-Unit hot plate illustrated in Fig. 389 is of the type in which the units are readily

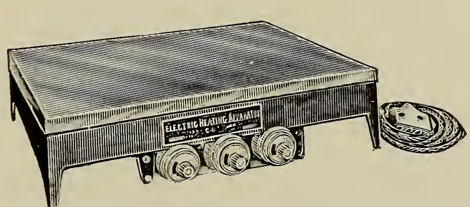


Fig. 389.—Multiple Unit Electric Heater.

renewable by the operator. The base and top are cast iron, and the units, 2 or 4 in each plate, are of moulded "Electrobestos," grooved to receive the heating elements, which are imbedded in a refractory cement. The top plate rests on the units, free from contact with the base, which prevents loss of heat by conduction. The units rest on bricks of low thermal conductivity, having a conductivity of about one-tenth that of ordinary fire bricks. This forces to the top of the plate a maximum amount of heat generated and affords a comparatively cool atmosphere to the underside of the apparatus. The increased efficiency is a net saving in current cost; gives higher temperatures and quicker

maximum heats. All sizes, whether of the three-heat or single-heat type, give maximum temperatures of at least 750° F. (400° C.) The three-heat type gives approximately 400° F. (250° C.) on low heat and 600° F. (315° C.) on medium heat, when used on 110 or 220 volts.

Digestion Flasks and Distilling Apparatus.

Separate determinations of nitrogen are made by the Kjeldahl process, in which the substance is boiled with mercury and acid until all is decomposed and the nitrogen converted into ammonia. Then the ammonia is distilled off into standard acid, and the amount neutralized shows the amount of nitrogen as ammonia.* It is necessary to discriminate between the nitrogen of the rubber and that of the

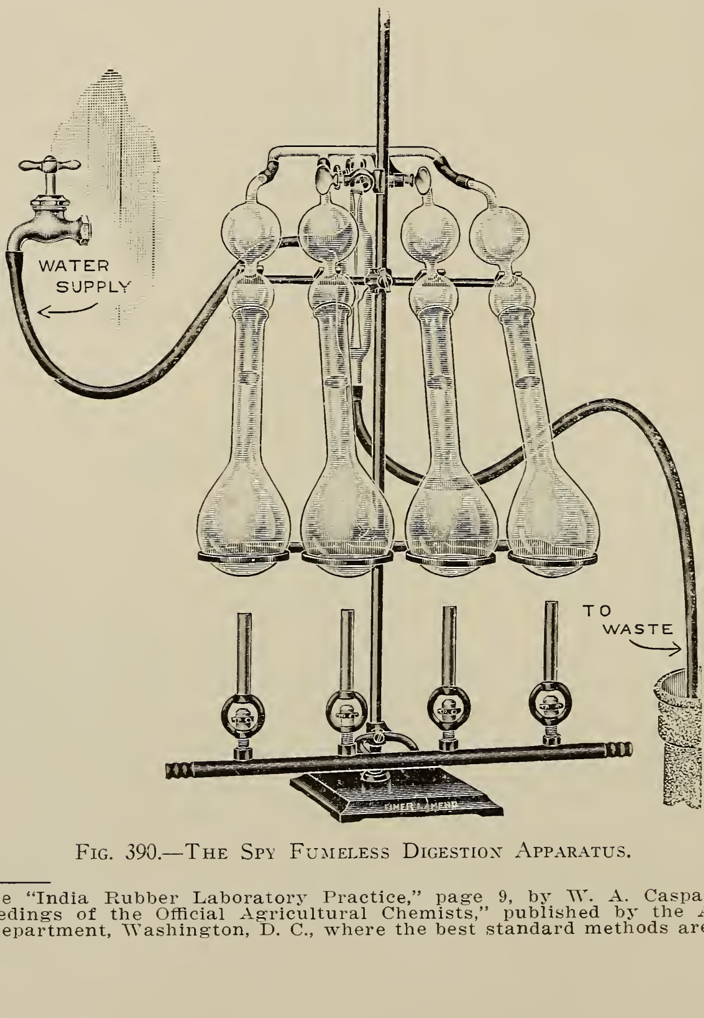


Fig. 390.—The Spy Fumeless Digestion Apparatus.

*See "India Rubber Laboratory Practice," page 9, by W. A. Caspari, also "Proceedings of the Official Agricultural Chemists," published by the Agricultural Department, Washington, D. C., where the best standard methods are given.

impurities, as the former is advantageous while the latter seems to exert a deleterious effect. The following digestion and distilling apparatus are used in this work.

The Spy Fumeless Digestion Apparatus.

This apparatus, illustrated in Fig. 390, permits of digestions being made in any place having a water supply and drain, without the use of fume closet. The fumes produced in the flasks will be sucked through the bulb tubes or absorbers to the drain as long as water is connected with the pump and running at a fairly good pressure. The flasks can be taken out of the ring clamps to gently shake contents without dismantling the apparatus. The entire apparatus is portable, each part being neatly fitted to the heavy iron support.

The Kjeldahl Distilling Apparatus.

A most convenient form, that can be made to hang on the wall or with support to stand on the table, is shown in Fig. 391. It

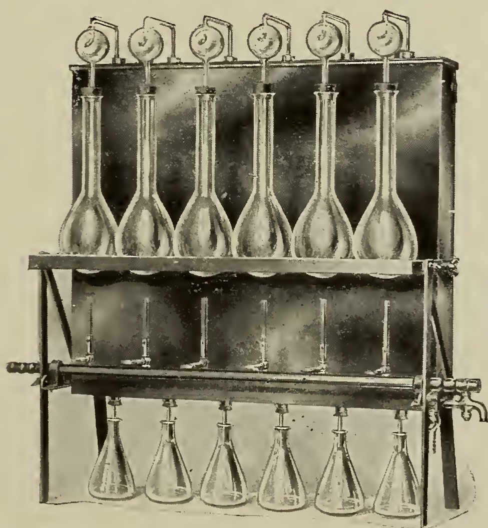


Fig. 391.—The Kjeldahl Distilling Apparatus.

comprises a polished heavy copper condenser with block tin condensing tubes, support for flasks and a set of E. & A. adjustable burners for use with natural illuminating or gasoline gas.

VISCOSIMETERS.

The testing of rubber solutions for viscosity is a physico-chemical test but may be made of importance if the uncured or raw rubber is dissolved in a standard solvent in a definite way. Fig. 392 shows the Saybolt or American standard, and Fig. 393 shows the Engler or European standard viscosimeter for petroleum testing. These depend on the dripping of a definite quantity of solution through a hole of certain size while temperature and other conditions are standardized. Fig. 394 shows the Doolittle viscosimeter, which depends on the twisting and untwisting of a wire and its retardation to show the viscosity.

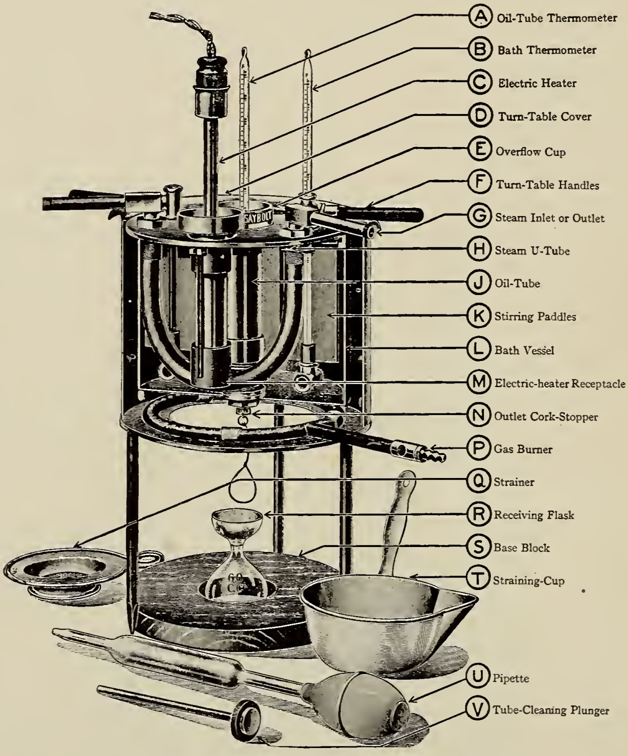


FIG. 392.—THE SAYBOLT VISCOSIMETER.

Redwood* describes all kinds of viscosimeters at great length, and all works on petroleum or oil analysis usually describe several. Thus Lewkowitsch† describes the Engler, Saybolt, Redwood and other vis-

*"Petroleum and its Products," by Sir Boverton Redwood. Second Edition, 1906; Third Edition, 1913.

†"Chemical Analysis of Oils, Fats and Waxes," by Dr. J. Lewkowitsch, F. I. C. F. C. S.; London, 1898; also later editions.

cosimeters. Testing the viscosity of a rubber solution is about the only way known to determine the relative polymerization of the rubber; and the value of the rubber depends largely on its state of polymerization.

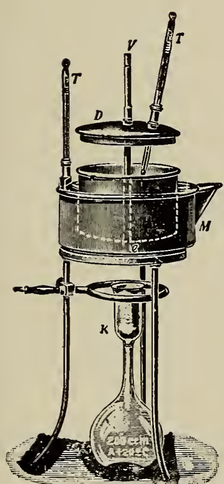


FIG. 393
ENGLER VISCOSIMETER.

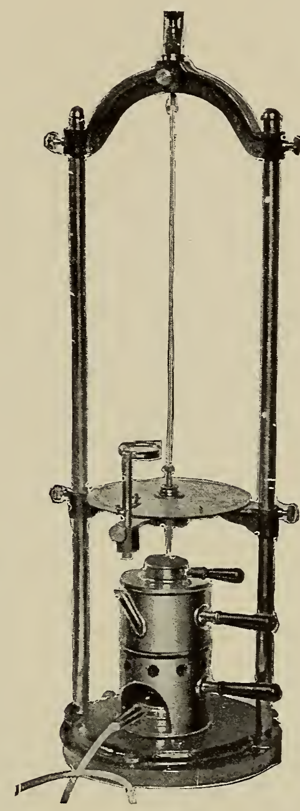


FIG. 394.
DOOLITTLE VISCOSIMETER.

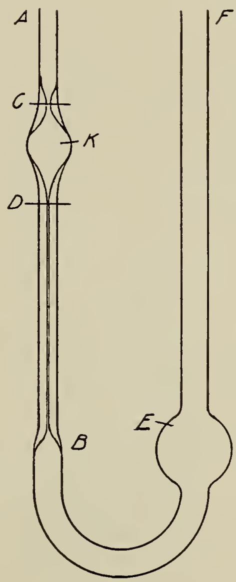


FIG. 395.
OSTWALD VISCOSIMETER.

THE OSTWALD VISCOSIMETER.

Fig. 395 shows the viscosimeter largely used by rubber chemists, particularly in Europe, owing probably to Ostwald's prestige as one of the greatest authorities on colloids. It consists of a single U-shaped glass tube expanded into bulbs at two points and contracted at one point to a capillary tube. In use, the tube is filled through F until the lower bulb E is nearly full. Then the apparatus is plunged into water of definite temperature, and when it has attained this temperature the solution is forced up until it passes through the capillary

tube *B* to the bulb *K*, filling it to above the mark *C*. This is done by air pressure on *F* or suction on *A*. The pressure of suction is then removed and the liquid level allowed to fall to *D*, the time being noted that it requires to pass from *C* to *D*. This time is the measure of viscosity. The instrument is graduated by determining the time that water or some other standard liquid takes to flow through the same space, from *C* to *D*. One advantage of the apparatus is its simplicity and ease of cleaning and of keeping under a fixed temperature. It will not, however, work on very viscous solutions and is never used in the petroleum industry in the United States, where viscosity determinations are of most importance and made on the largest scale.

The Frank Viscosity Apparatus.

Dr. Fritz Frank proposed for the German section of the International Testing Committee an apparatus to consist of the following parts (Fig. 396): The receiver *A* is a pear-shaped glass vessel, with an inflow socket *B* provided with a ground stopper, and at *C* with a similar socket which carries the aluminum closing rod *D*. The vessel has three marks for the measurement of 200cc. The three marks

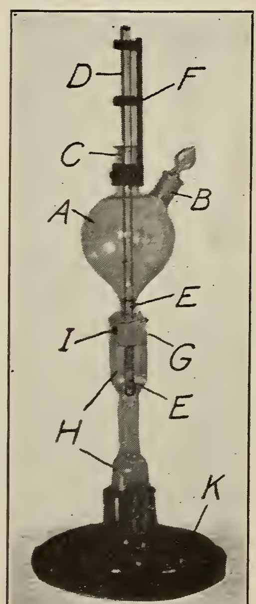


Fig. 396.
The Frank Viscosity Apparatus.

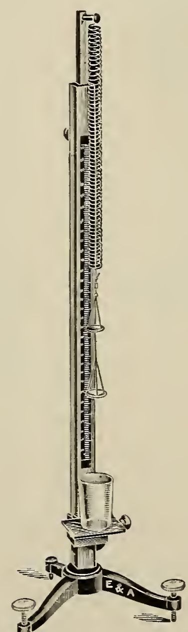


Fig. 397.
The Jolly Spiral Balance.

serve for measuring in and at the same time for the establishment of a certain level. At the lower end, the vessel has a discharge pipe *E* of metal of a predetermined length, which is firmly set in a glass socket. The closing rod *D* is ground to close this outlet perfectly and is carried by guides in the holder *F*. By means of the ground collar *G*, the glass vessel *A* is attached to the receiving cylinder *H*. Both grindings have connecting openings at *I* to allow the air to escape, or by slightly turning the vessel *A* they may be closed. The receiving cylinder *H* is graduated, and from the 95 cc. to the 105 cc. mark is contracted to permit accurate reading. The cylinder is mounted on a broad wooden base *K*. The dimensions are invariable.

In use, the discharge opening is closed and the glass retort *A* is filled with the solution exactly to the 200 cc. mark. For the measuring temperature, 20° C. is always employed. In the older apparatus, the cock was turned from stop to stop; in the new apparatus, the closing rod *D* is raised by a quick but steady movement to the stop and at the same time the stop-pin of the stop-watch (seconds watch) is pressed open. As soon as the fluid has run as far as the 100 cc. mark down into the lower vessel, the closing rod and stop watch are simultaneously set and the elapsed seconds noted. As so far no unit has been established, it is possible only to give the time required for 100 cc. of the solution to run out. The second determination of viscosity is carried out after 8 or 10 days with the remainder of the solution, which must be kept in a dark place.

Apparatus for Determining Specific Gravity.

The ratio of bulk to weight is of great practical importance in the rubber industry, because it controls the number of pieces or feet per pound obtainable from any given stock. This relation of bulk to weight is dependent on the specific gravity of the material. Its determination presents a constantly recurring problem.

The method of determining specific gravities of solids depends on the fact that any substance immersed in water loses weight equal to the weight of the volume of water which it displaces. The means of ascertaining specific gravities vary somewhat according as the substance under examination is solid, liquid, or a gas. The density of any substance bears the same proportion to the density of water as the weight of the substance bears to the weight of its bulk of water. Hence if the weight of the body, in air, is divided by its loss of weight, when weighed in water, this quotient will represent the specific gravity of the body.

Every chemical balance is provided with a hook at either end of the beam for use in suspending a sample to permit its weight to be taken in water, the glass containing the water being placed on a support standing on the floor of the balance case and astride the scale pan.

The Jolly Spiral Balance.

The Jolly spiral balance, so called from its inventor, is especially useful for obtaining rapidly the specific gravities of minerals and rubber samples. It is illustrated in Fig. 397 and consists of an upright supported on a heavy iron base, which is provided with leveling screws. Extending the full length of one side of this upright is a mirror upon which is engraved a fine decimal scale. Sliding on the upright is a small adjustable platform for supporting a glass of water. Within the upright is a light adjustable wooden rod carrying an arm for holding one end of the weighing spiral of wire which supports at its lower end the connected pans. Three spirals of various degrees of tension are provided with the instrument to regulate its sensibility to heavy, medium, or light materials. The pans are suspended from the medium spiral, the lower pan of glass, hanging freely in a receptacle filled with clean distilled water. If such water is not available, clean cool water, that has been previously boiled to expel the dissolved air, will answer very well.

To make a specific gravity determination, begin by adjusting the glass of water at such a height that the lower pan will be immersed to some point above where its supporting wires meet. Allow the pans to come to rest, and note the reading on the scale of the height of some fixed point, as the top of the white bead. The scale is engraved on a mirror in order that a level reading may be taken by sighting the point selected for reading with its reflection. Every reading must be made from one reference point. Record this reading taken with the pans empty. Then place in the upper pan a small piece of the rubber or other material to be tested, of suitable size (and any shape). Again adjust the level of the glass so that the pans may hang free and with the lower pan immersed as before. When equilibrium is established note the second reading of the same reference point and record. In precisely similar way determine the reading of the reference point again with the sample in the lower pan immersed. Care must be taken to free the sample of all adhering air bubbles which would otherwise falsify the reading. Note the third reading and the data will be ready for calculation. These readings represent, in terms of spaces on the scale, (1) the weight of the pans unloaded; (2) the

weight of the pans and substance in air; (3) the weight of the pans and substance in water.

The difference between the first and second readings stands for the weight of the sample in air. The difference between the second and third readings represents the loss of weight of the sample in water. Divide the weight in air by the loss of weight in water and the result will express the specific gravity. For solids lighter than water it will be found necessary to close the wires of the lower pan more or less around the sample to keep it immersed.

The Nicholson Hydrometer.

Another and simpler instrument for obtaining specific gravities of solids is shown in Fig. 398. This is made of thin sheet metal of

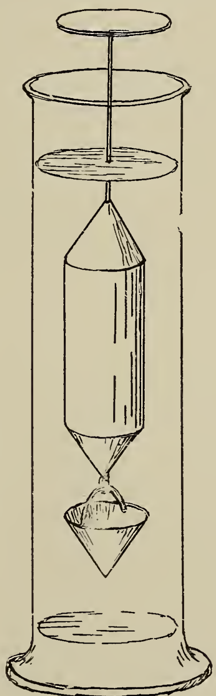


Fig. 398.
The Nicholson Hydrometer.

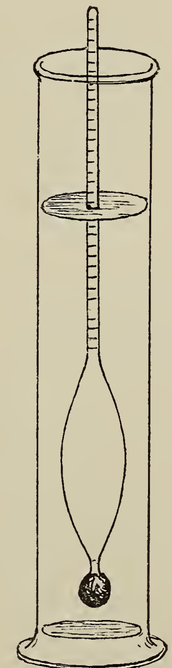


Fig. 399.—Ordinary Hydrometer and Cylinder.

hydrometer form, and provided with a set of small weights. It is inexpensive and accurate, but not as convenient to use as the Jolly balance. Above and below the body of the hydrometer are pans for holding the sample. On the stem is a reference mark to which point the instru-

ment is always sunk in the jar of water before each reading is taken. Briefly described, its use is as follows: * Let w_1 be the weight required to sink the instrument to the mark on the stem, the weight of the instrument being w; to take the specific gravity of any solid substance place a portion of it weighing less than w_1, in the upper pan, with such additional weight, say w_3, as will cause the instrument to sink to the zero mark. The weight of the substance, in air, is then $w_1—w_3$. Next transfer the substance to the lower pan, and again adjust with weight w_4 to the zero mark. The loss of weight of the substance in water is then $w_4—w_3$. Therefore the specific gravity is obtained by this formula:

$$\text{Specific gravity} = \frac{w_1 - w_3}{w_4 - w_3}$$

For materials in the form of powder the specific gravity bottle is used. This is of various forms, but is essentially a small flask provided with a reference mark on the neck. A fine chemical balance is necessary to make the weights and the procedure is as follows for solids heavier than water:* Weigh the flask filled to the mark with water, then place the substance, of known weight, in the flask, fill to the mark with water, and weigh again. The calculation will be:

$$\text{S. G.} = \frac{\text{(Weight of substance in air)} + \text{(weight of flask and water)} - \text{(weight of flask and water and substance)}}{\text{(weight of substance in air.)}}$$

Specific gravity is not to be taken as a test for quality as applied to rubber stocks, but simply as a guide to the economy of the stock. Another practical application is found in estimating the weight of a proposed article of solid stock when its cubical contents is known. The weight for water of the cubical contents is ascertained by multiplying by 252.5, the weight in grains of one cubic inch of water. This product multiplied by the specific gravity of any material will give the weight of the object in that material. Thus an article of 10 cubic inches volume would weigh, if made of a rubber stock of 1.85 specific gravity:

$$10 \times 252.5 \times 1.85 = 4671.25 \text{ grains} = 10\ 2/3 \text{ oz.}$$

Turning to the consideration of the means of obtaining the gravities of liquids such as acids, oils, naphtha, etc., we have the various

*From Bailey's "Chemists' Pocket Book."

forms of hydrometers and balances. There are many specially designed hydrometers adapted to the requirements of certain industries, but in principle they are all alike.

Ordinary Hydrometer and Cylinder.

Fig. 399 shows the ordinary type of hydrometer, which consists of a weighted glass bulb sinking the instrument upright in the liquid. The degree or actual specific gravity is read by means of graduations on the stem. The ordinary Beaume hydrometers are those in general use. Two instruments are required, one weighted and graduated for liquids heavier than water and one for those lighter than water. The Beaume scale of "degrees" is arbitrary and to ascertain the specific gravities a table must be consulted. For ordinary trade purposes the Beaume degree is used and is all that is required.

The Westphal Balance.

The balance shown in Fig. 400 is adapted to either light of heavy liquids and by its aid the gravities are read direct from the weights

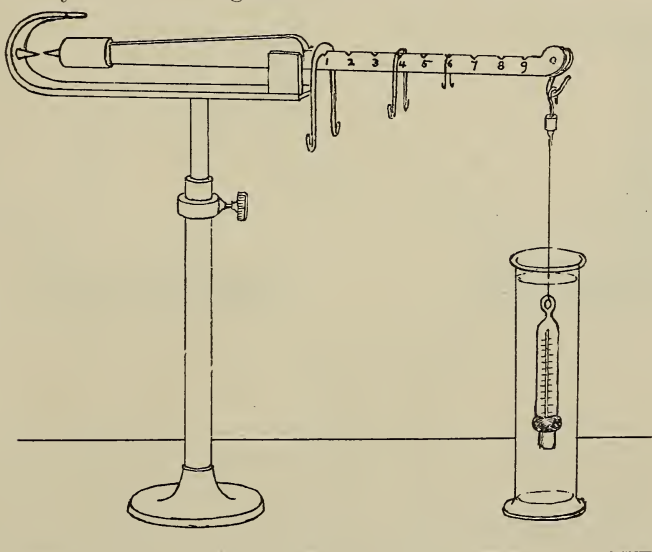


Fig. 400.—The Westphal Balance.

used without calculation. It is also convenient when only small samples of liquids are available for examination. The balance is so readily adjustable that the glass bob will balance the counterweight on the opposite arm when hanging in air. When suspended in any liquid a buoying effect, dependent on the gravity of the material,

throws the instrument out of balance. The equilibrium is re-established by a set of rider weights. Reading the position on the beam of the weights in the order of their size gives the specific gravity at once.

The Young Gravitometer.

A direct reading specific gravity balance for solid, pigments or other finely divided materials insoluble in water is shown in Fig. 401.

The balance is leveled by a screw in the base, as seen in the figure on the left. The sample of rubber or other material to be tested is suspended on the needle point and the weight on the beam moved in the direction necessary to bring the index to the point

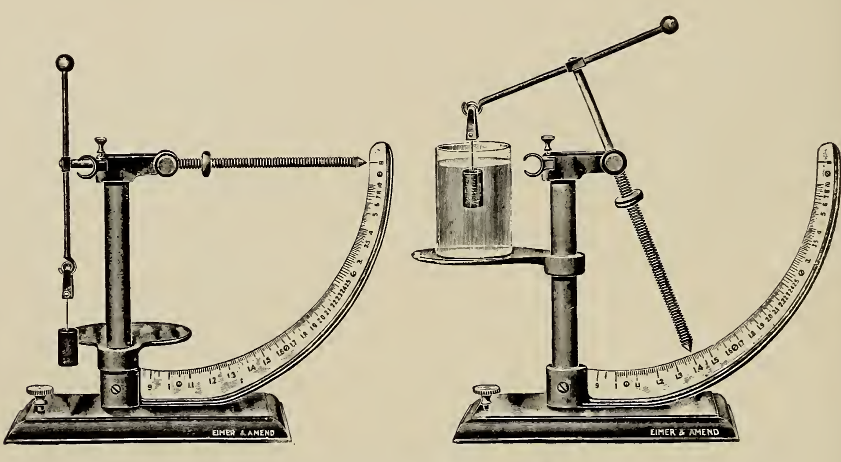


Fig. 401.—The Young Gravitometer.

marked oo on the graduated arc. The glass vessel, filled with water, is then placed on the platform, which is raised until the sample is fully immersed. The pointer will then move along the scale and indicate the specific gravity, as shown in the figure on the right.

For testing pigments, a receptacle is provided, which is suspended in the place of the hook. The operation is the same as with solids, except for the use of the counterweights.

The Rost Apparatus.

Fig. 402 shows an apparatus which consists of a graduated cylinder A fixed in a wooden base, two pipettes B and C for filling and a

solution of chloride of zinc with a specific gravity of 200. The procedure is very simple and quickly gives the exact statement of the specific gravity.

For the denser grades of rubber which are likely to be heavier than 0.45, fill the cylinder with zinc chloride solution exactly to the lowest line, 2.0—if possible without wetting the upper part of the tube. This is done with one of the pipettes. Then put the piece of rubber in the cylinder, having first moistened it, to prevent air bubbles. If the rubber is specifically lighter than 2.0 it will be suspended in the upper part of the mixture. Now add water with the other pipette, drop by drop, frequently stirring the fluids, as long as the piece of rub-

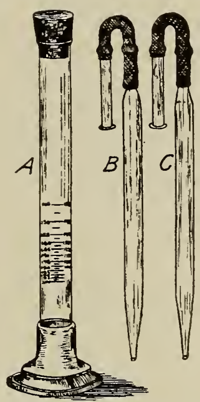


Fig. 402.—The Rost Apparatus.

ber is in the midst of the mixture. The mixing is best done by slowly turning the cylinder after having closed it with a stopper. Heavy shocks are to be avoided. The number on the left of the cylinder which the liquid has reached, after standing a short time, gives the specific weight of the rubber.

For rubber having a weight of 1.0 and 1.5, a contrary procedure is adopted. Fill the graduated cylinder with water to the line 1.0 on the right side, then add zinc chloride solution as described above, until the piece of rubber is swimming in the mixture. The number on the right side of the scale gives the specific weight of the rubber.

Specific Gravity and Compound Cost Calculator.

Young's device, illustrated in Fig. 403, is used for calculating gravities from the formulæ of compounds. It will be seen that the important compounding ingredients have been plotted on the slidable chart, on lines which correspond to the reciprocals of their gravities.

The operation for determining the specific gravity of a compound from its formula is as follows: The slide *B* is moved vertically until the index *A* is at the percentage of the first ingredient. Then the cross slide is moved until the index *C* is at that ingredient's line, and the runner is moved to the left on the cross slide until it comes to

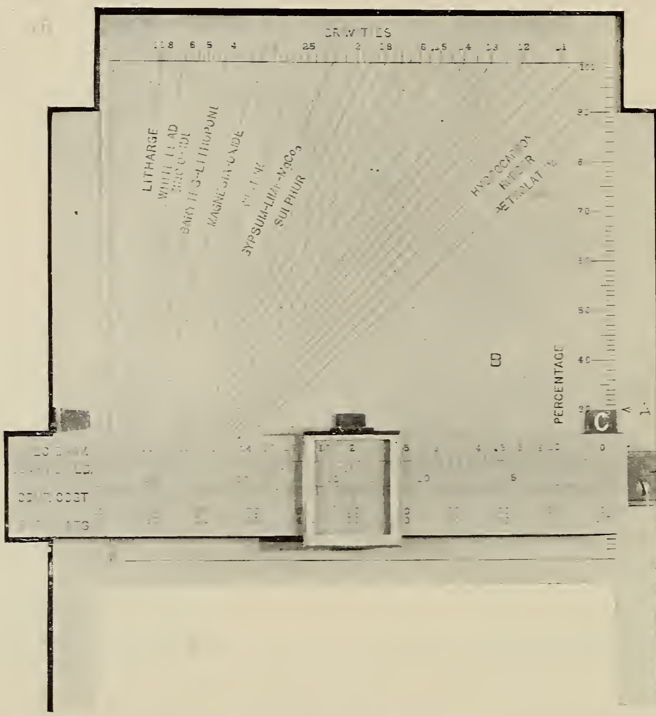


FIG. 403.—SPECIFIC GRAVITY AND COMPOUND COST CALCULATOR.

the left stop. The slide *B* is then moved so that the index *A* registers at the percentage of the next ingredient, and the cross slide carrying the runner is moved to the right until the runner index is on that ingredient's line. This operation is repeated until all of the ingredients have been introduced, and the gravity is read on the upper scale under the hair line.

For an ingredient which has no line on the chart it is possible to interpolate between the lines as plotted, knowing, of course, the gravity of the ingredient.

The slide *B* is reversible, and on the opposite side are lines which may be used in the calculation of compounding cost, or the batch weights from the percentages in the compound.

Sampling.

Nearly all vulcanized rubber can be ground on the rubber mill, shown in Fig. 369, to any required degree of fineness, and where these machines are available they are the most satisfactory means of

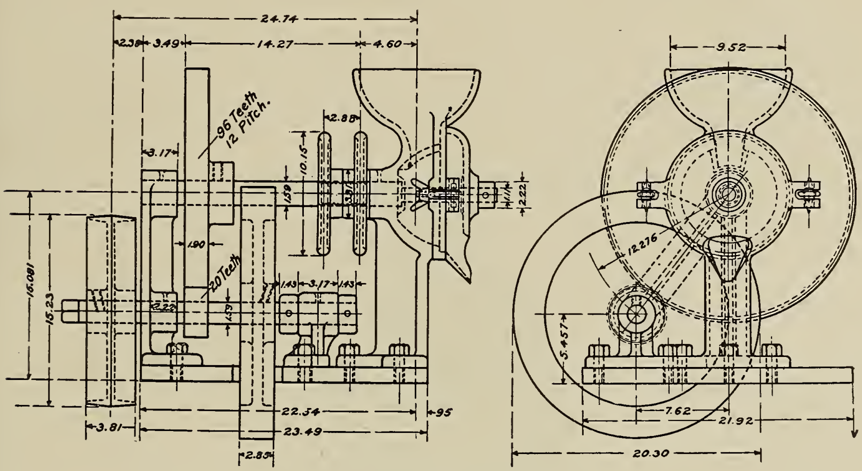


Fig. 404.—Grinding Mill.

getting a sample of most goods. The Joint Rubber Insulating Committee* prescribes the mill shown in Fig. 404. In this the grinding plates are adjusted so that not more than 20 per cent. of the rubber will pass through a 40-mesh sieve. The material is then sifted through a 20-mesh sieve and is ready for use. For the analysis of the inorganic fillers the usual laboratory apparatus is used.

Physical Testing of Rubber.

The value of rubber goods usually depends on the peculiar elasticity and resilience of rubber itself, together with its electrical resistance in some cases. Its resistance to water and the elements generally is also important, as is its resistance to chemicals. Therefore the physical testing of manufactured rubber articles is of greatest importance.

*"Journal of Industrial and Engineering Chemistry," January, 1914.

The tensile strength of most rubber goods can be determined on any of the usual tension machines, provided they are adapted to take care of the great stretch.

Test Pieces.

The European testing machines as a rule call for rings, while the American specify strips. Mills, who has done research work for the largest American rubber plants, thus discusses the two forms and describes his strip cutting apparatus.

*"Although the ring form of test piece is popular, many prefer the straight test piece, as it does not involve certain errors to which the ring is subject.

"Fig. 405 shows a hand operated press for cutting standard test rings, and Fig. 406 shows a device for cutting test strips.

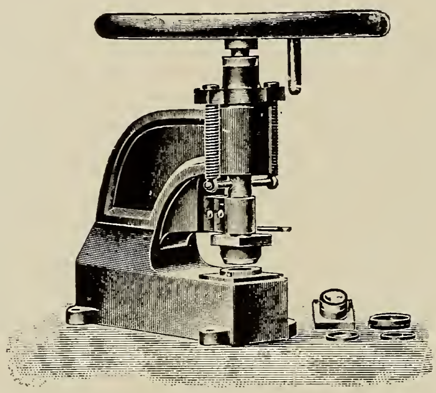


Fig. 405.—Punch Press for Standard Rings.

"All those who have tried punching test pieces will appreciate the difficulty in preparing uniform pieces of a regular cross section that can be easily measured. The softer the stock the more it yields under the knife or punch, and the more likely will the section depart from the desired shape.

Strips may be molded into the desired form, but it is difficult to obtain uniformity throughout the narrow portion. It is essential that the section should be uniform and easily measured, also that the edges should be clean, as a tear will readily follow a slight check. It has been found much more satisfactory to punch away the sides of a flat strip, leaving the test portion between two stout ends.

*H. P. Mills, "Journal of Industrial and Engineering Chemistry," June, 1912.

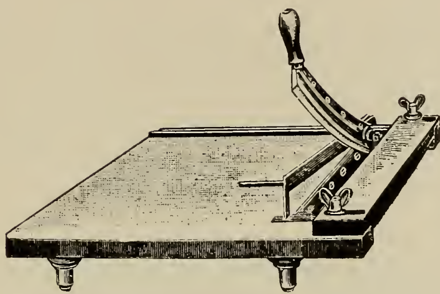


FIG. 406.—DEVICE FOR CUTTING TEST STRIPS.

FIG. 407.—PUNCH PRESS FOR STRAIGHT STRIPS.

"The strip is molded in bolted molds. Referring to Fig. 407, a sharp, thin, curved knife is set firmly in the vertical slide. A stop prevents it from touching the cast iron bed plate. A 'nest' into which the strip fits snugly prevents the rubber from spreading while being cut. The nest is secured to the bed plate by thumb screws, and it can be adjusted to the thickness of the strip.

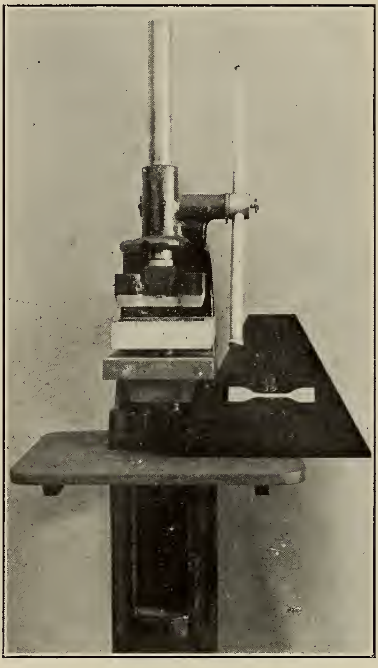


FIG. 408.—STRAIGHT STRIP CUTTER.

"A few thicknesses of manilla paper are placed under the strip in the 'nest' and one side is punched out. The knife is so shaped that a little of the rubber at each end is left uncut; thus, when the strip is lifted out, the punched pieces still adhere to it. Without removing this piece the strip is replaced in the nest, this time with the cut edge forward. Care is taken to have the same surface up in both cases, as the parallelism of the width of the test pieces is thereby assured. The second side is punched out, the strip taken out of the nest and the punched pieces torn or cut free. Two marks at a unit distance are then placed on the strip, which after measuring is ready for testing."

Grinder for Test Pieces.

The machine shown in Fig. 409 is for the purpose of preparing samples of uniform cross section to be used for tests for tensile strength. It was designed primarily for grinding off the rubber in preparing samples for testing the breaking strength of rubber hose lining.

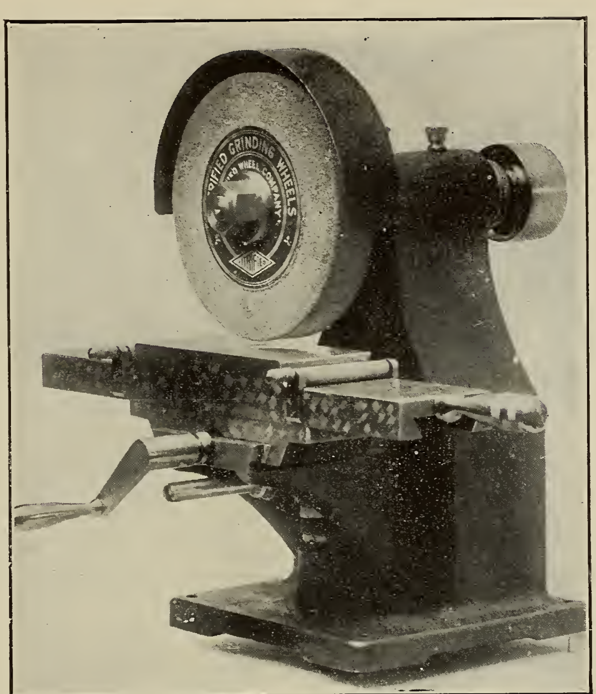


Fig. 409.—Grinder for Test Pieces.

The rubber-backed interior lining is stripped from the fabric of a section of hose several inches in length. This strip of rubber is cut to a uniform width of one inch throughout a distance of 3 or 4 inches along the middle of its length. The strip is then strapped closely to the platen of the grinder, being held firmly in position by the eccentric rolls shown in the cut. The strip is placed with the smooth side to the platen, leaving uppermost the rough side composed of the rubber backing, which is then ground off from the lining. This machine requires less than $\frac{1}{4}$ horse power for its operation and is driven by a belt or motor drive.

Test Piece Grips.

In testing rubber, one of the greatest difficulties has been to grip the test piece in such a way as to prevent slipping without at the same time injuring the rubber. Even a very small scratch on the surface of a test piece is often sufficient to cause failure at that point.

In order to prevent slipping of the test piece as its section is gradually reduced under increasing tension it has been found advisable to provide means for automatically tightening the grip. This is conveniently accomplished by using a cylindrical roller mounted eccentrically as illustrated on the left in Fig. 410. When the rubber varies

Fig. 410.—Test Piece Grips.

in thickness, as is often the case, it is an advantage to use a number of thin cylindrical discs as illustrated on the right. These act independently, producing a uniform pressure over the gripping surface and preventing any uneven slipping.

Testing Devices.

The Schopper-Dalen Machine.

The tester shown in Fig. 411 is worked by hydraulic power, its operation, briefly stated, being as follows: The rubber test ring is placed over the spools and the lower spool is geared to the rack in such a way that it is caused to revolve during a test. This motion is transmitted to the top spool by the rubber test ring, the object of rotating the spools being to equalize the tension at all parts of the specimen. As the tension is increased the weighted lever, to the short arm of which the top speed is attached, is gradually deflected. When the test ring is broken the lever is held at the point of maximum load by means of a set of pawls, the breaking load being read from the curved scale and the elongation being indicated by the vertical scale just opposite the test ring.

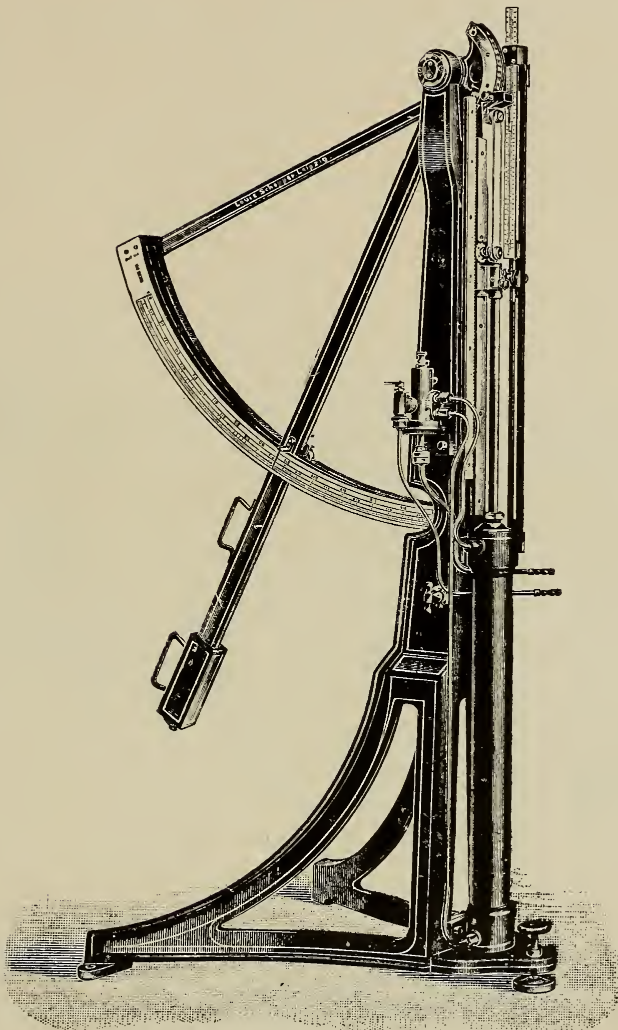


Fig. 411.—The Schopper-Dalen Machine.

The Olsen Autographic Machine.

The machine in Fig. 412 uses a test strip, $\frac{1}{8}$-inch thick, 1 inch wide and 6 inches long, reduced in the middle to a width of $\frac{1}{2}$-inch for a straight length of 2 inches, on which length the stretch is taken. Three independent tests with autographic records can be made—tensile test to rupture of the rubber, repeated load test to rupture of the rubber and time elongation test under dead load.

A weighing system which consists of a pendulum balance in which the pendulum has a weighing motion of 90°—45° either side of central position, obtained by use of the weight at the left end of the machine, which overcomes the gravity of the pendulum. The straining mechanism consists of a screw, which operates the straining head driven by a four to one variable speed motor, so speeds of from

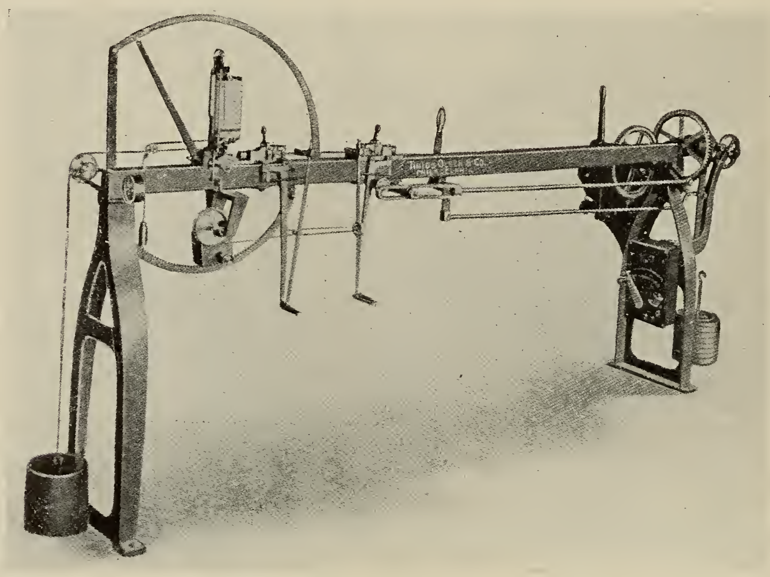


Fig. 412.—The Olsen Autographic Machine.

6 to 24 inches per minute are readily obtained. A repeated load of varying amount may also be applied by operating the hand lever to the right of the machine. This gives a reciprocating motion to the straining head. A quick release and hand return of the straining head is provided, and when dead load tests are made the head is released from the screw and the load applied at the extreme right end of machine. The rubber is gripped between two wedge rollers in each head which are operated simultaneously by hand levers.

The autographic records are automatically taken and reduced so that four magnitudes of records may be taken, depending upon the stretching quality of the rubber. One curve reduces the stretch on the diagram 5 times; one, 10 times; one, 20 times, and one, 40 times—so that all tests are reduced to a standard size diagram sheet.

The autographic time test is made by connecting the rotating autographic drum to the clock at the left, and thus a record is obtained showing the relation between time and stretch under any desired dead load.

The stretch is measured from special spring clamps fitted to the rubber, and an exact record is obtained by the autographic fingers taking the measurement of elongation from these spring clamps.

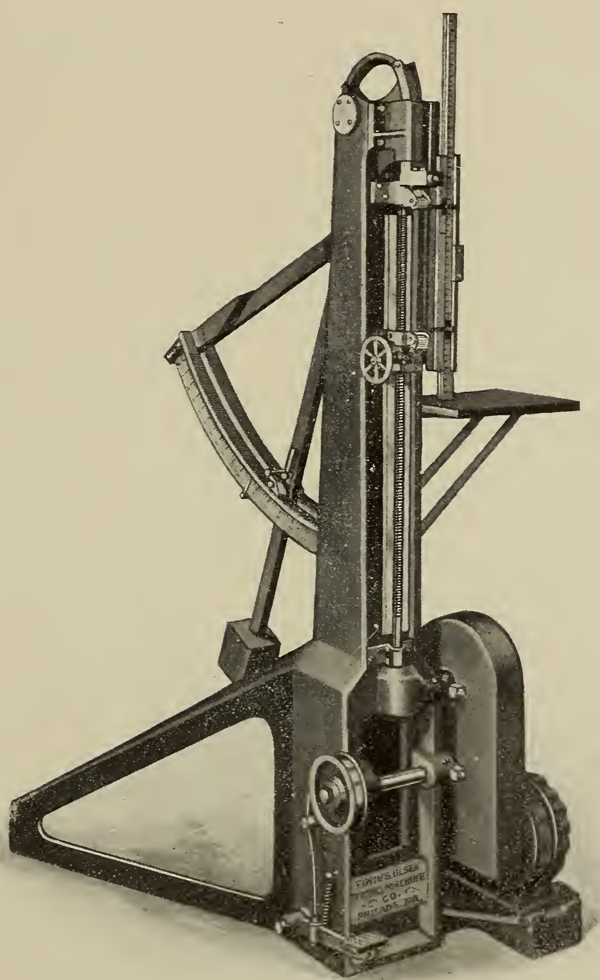


FIG. 413.—THE OLSEN STANDARD MACHINE.

THE OLSEN STANDARD MACHINE.

A comparatively new machine for testing the standard form of tensile test specimens is illustrated in Fig. 413. It is of the pendulum type, arranged so the scale will weigh in three magnitudes, either to a maximum of 50 pounds, 100 pounds or 200 pounds, depending on the grade of material to be tested. The machine is driven by a direct connected motor and is made with or without attachments for measuring elongation.

THE SCHWARTZ HYSTERESIS MACHINE.

This machine, shown in Fig. 414, extends the test piece by a load which is increased at a given rate until either a given load or a

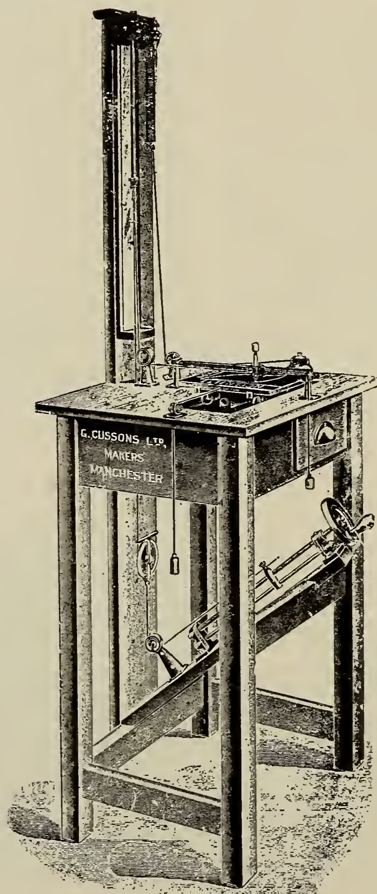


FIG. 414.—THE SCHWARTZ HYSTERESIS MACHINE.

given extension is attained. When this point is reached the load is diminished at the given rate and the rubber is allowed to retract. The relation between load and elongation is recorded by a pen, which draws two lines, one during extension and the other during retraction. What is known as the hysteresis loop made by this machine, is shown in Fig. 415. This is drawn upon a sheet of paper attached to the mov-

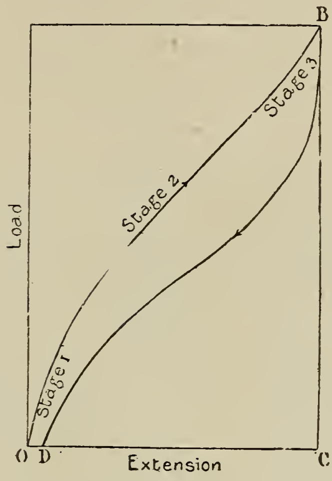


FIG. 415.—HYSTERESIS LOOP.

ing table. The line *O B* is made during extension and is the result of the stretch of the rubber and of a calibrated spring. *B D* is the retraction curve. The distance *D O* represents the sub-permanent set. The outlines of the curves indicate the physical properties of the rubber sample and thus determine its qualities and insulating values.

THE SHORE ELASTOMETER AND DUROMETER.

An instrument suitable for measuring the hardness of soft rubber is unsuited for hard rubber; also, one that will determine elasticity of soft rubber is unsuited for hard rubber. To successfully measure the properties named, the Elastometer for elasticity, and the Durometer for hardness, shown in Fig. 416, have been devised.

The Durometer when applied to soft rubber indicates its resistance to the penetrating force of a blunt pin. This pin projects from the instrument three thirty-seconds of an inch and is held by a carefully calibrated spring. On the harder grades it is pushed in most of its length against the tension of the spring. The extent of the compression, and. conversely. the deformation of the rubber, are indicated on

the dial, expressing units of hardness. The size and position of these units, since the value 50 is the average hardness for soft rubber, have been carefully chosen and obviously will remain constant.

In testing the elasticity of rubber with an instrument that is to be applied to the surface without damage, the stretch test is most closely imitated by one involving a tearing or cutting stress. Rubber having 100 per cent. elasticity will resist the penetration of a knife or a sharp point for a given depth without cutting in the slightest degree. Should, however, the elasticity be somewhat imperfect, the cutting will take place to the extent that the elasticity is deficient, until

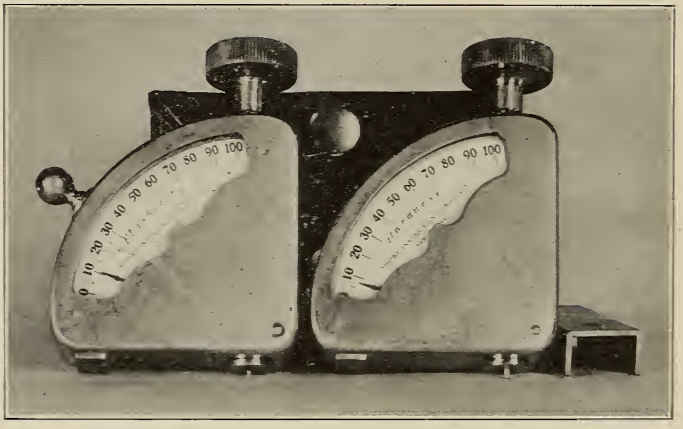


FIG. 416.—THE SHORE ELASTOMETER AND DUROMETER.

at last the elasticity is so low at a given hardness that cutting will occur almost the entire distance penetrated. The Elastometer has been devised by applying this principle. The action is as follows: A medium sharp pin, three thirty-seconds of an inch long, is locked and caused to penetrate its entire length into the rubber. After a few seconds the pin is unlocked and is pushed back by the rubber, according to its power to recover its original form or its elasticity. The pin actuates a very delicately balanced indicating needle, reading in percentages of elasticity. If it is pushed back only half way, 50 per cent. is shown; if all the way, as when the rubber suffers no injury at all, 100 per cent. elasticity is shown.

THE PLASTOMETER.

The Plastometer, shown in Fig. 417, is an instrument by which the quality plasticity may be indicated. Its method is direct reading

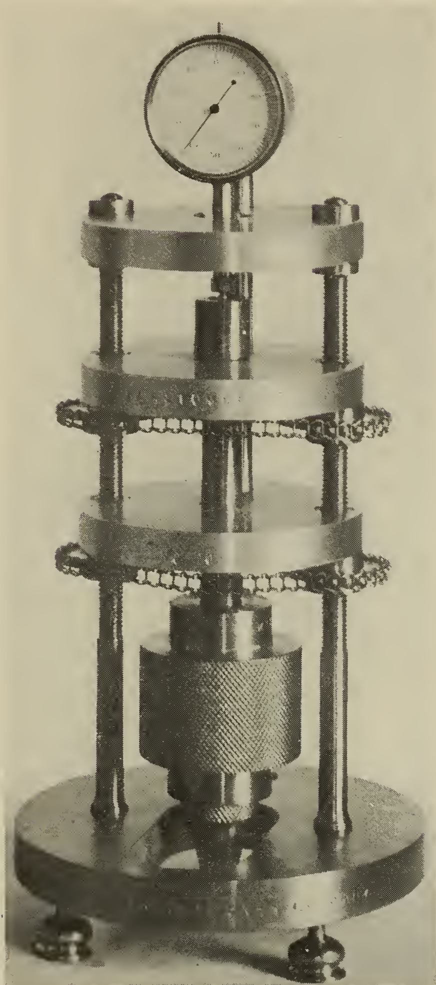


FIG. 417.—THE PLASTOMETER.

without injury to the material tested, i.e., unlike a "tensile-test" in which the material is tested to its destruction. It has a combination of parts whereby a weight may be supported wholly upon a sphere, sufficiently hard to sustain such load without appreciable deformation, and means whereby the amount of penetration or indentation is determined at the expiration of one minute.

Most grades of crude rubber may be tested by the Plastometer in which the sphere is a hardened steel ball, ¼-inch in diameter, upon which is placed a weight of one kilogram, the penetration or indentation of such ball being indicated by the micrometer dial gage, indicated to one one-hundredth millimeter. Softer materials require a larger ball, or less weight, or both. Harder materials require a smaller ball, or more weight, or both.

The Shore Scleroscope.

The Shore Scleroscope, Fig. 418, records the hardness or resistance to penetration, as shown by the height to which a small plunger ham-

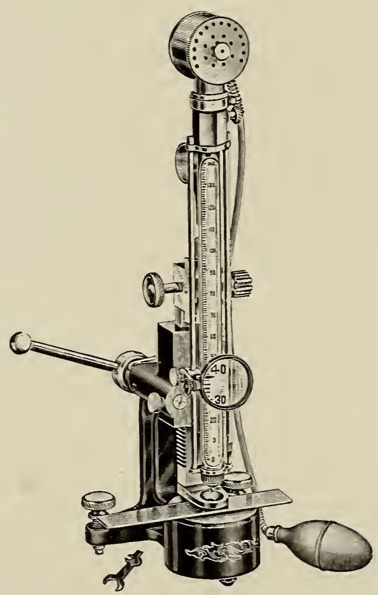


Fig. 418.—The Shore Scleroscope.

mer will rebound. The hammer is equipped with a point so shaped that there is always a recoil. A scale registers the extent of the rebound and thus definitely shows the relative hardness of the material tested.

Elasto-Durometer.

Breuil's apparatus measures the elasticity and hardness of rubber. Fig. 419 is a sectional view of the device arranged for taking measurements of hardness. A brass tube *D* is screwed into the upper plate. In this is placed a helical spring which bears at one end on

the base *B* of the shank *A* and at the other end on a head piece *C* which is screwed on the tube *D*. The shank *A* is graduated at its upper end, and this graduation serves to measure the distance by which the head piece *C* is displaced with reference to the tube *D* when one is screwed over the other. In this way the amount of pressure on the spring is measured at *E*, consequently, if the spring has been gaged the pressure which it will support is known. The

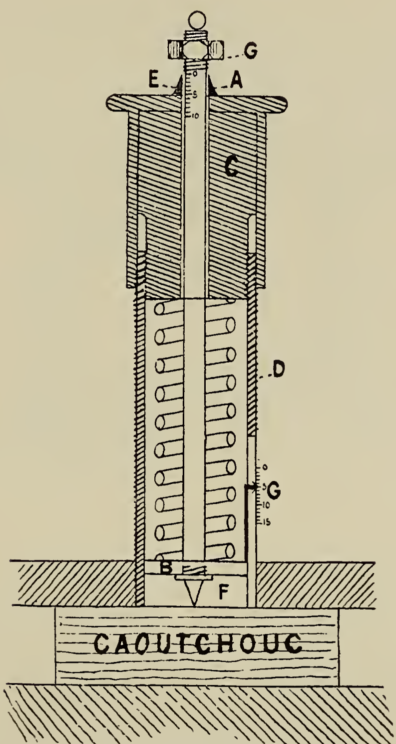


Fig. 419.—Elasto-Durometer.

lower end *B* of the shank *A* carries a point *F* which, under the pressure of the spring penetrates into the material to be tested. This base has a vernier index *G* which shows the amount of the penetration in tenths of a millimeter. There are, it will be seen, two characteristics of the test, the pressure and the depth to which the point is forced.

The P. B. Dynamometer.

Fig. 420 shows the P. B. Dynamometer, which consists of a solid cast iron table supporting the two principal parts, the apparatus pro-

ducing the stresses and the appliance for measuring them. On the table is a horizontal spring balance which carries one of the jaws to hold the test piece. Means are provided to recalibrate the spring, and the pointer remains at the maximum indication on the breakage of a specimen, thus recording the breaking load.

The load is applied either with a hand wheel and bevel gears for quick motion or through worm gears for heavy loads at low speed. Pulsating stresses of any desired amplitude can be applied by an

Fig. 420.—P. B. Dynamometer.

eccentric gear at adjustable speeds. Samples can be tested in a bath, by means of which the temperature can be varied. The apparatus also provides for compression, plasticity, repeated bendings, wear and friction tests, so that it is capable of being applied to a large number of purposes.

One of the important features of the "P. B." system is the possibility of determining by its aid both the wear and tear and the co-efficient of friction of rubber, fabric, etc.

The Falkenau-Sinclair Machine.

A machine for applying tensile tests to rubber is shown in Fig. 421. It consists of a movable bed plate upon which is a spring balance and a grip for the test piece, and between them a removable wedge which follows up the pull on the balance and holds it at the maximum strain when the break occurs. The strain is applied through a screw by means of power or the hand wheel at the end of the machine.

There is also a hand wheel at the side which operates a rack and pinion for moving the carriage rapidly to its original position after a test has been made. Opposite the movable grip is a fixed one, which, however, can be made movable by removing a stud. In

FIG. 421.—THE FALKENAU-SINCLAIR MACHINE.

this way tests for stretch and set may be made by attaching dead weights to the hook by means of a cord passed over the sheave. The machine is also provided with a graduated scale and pointers with which the original reference marks on the test piece may be followed as the specimen is stretched, and thus the elongation be determined.

THE CLAYTON MACHINE.

The Clayton dynamometer gives the resistance, the elongation at the point of rupture, the elongation under a given burden and the hysteresis curve.

The principal difference in contrast with the Schopper and the P. B. machines consists in the fact that Clayton's has neither spring nor weighted lever.

A stream of water reaches a balanced receptacle at the rate of one kilo (2.2 pounds) a minute. The weight of the water, reaching the point gradually, exercises traction upon the sample being tested. At the moment of rupture the stream of water is automatically stopped and the breaking load is found by weighing the amount of water in the receptacle. The stream can, moreover, be stopped at any time, in order to read off the extension under a given load. The quantity of water in the receptacle can also be gradually diminished. As may be understood, this dynamometer is remarkably easy to handle, while it is capable of giving results equally accurate and varied.

Cheneveau-Heim Recording Dynamometer.

This machine, shown in Fig. 422, resembles the Schopper machine but has a recording device *P* attached to the weight arm *O*. By means of a gear the cylinder revolves as the weight is raised. A rack and pinion revolves a smaller pinion connected with the chain beside the cylinder. This chain carries a pencil which registers a line on the

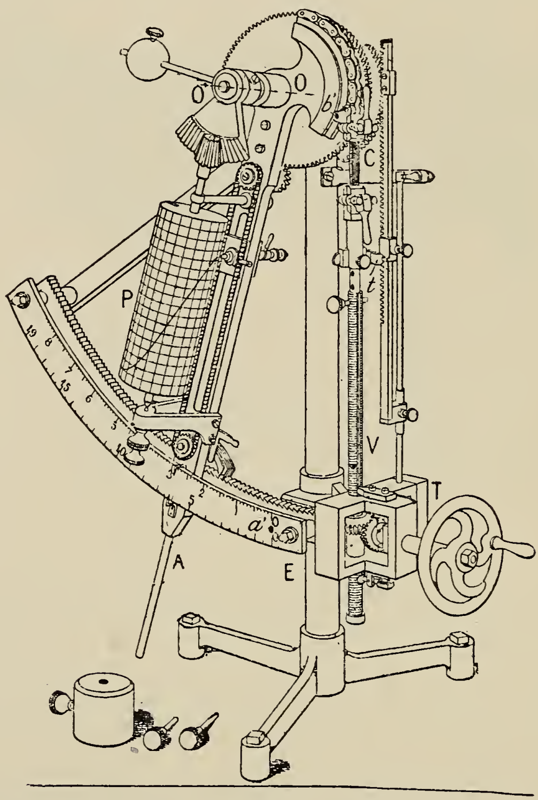


Fig. 422.—Cheneveau-Heim Recording Dynamometer.

cylinder. The height of the line represents the stretch, and the distance of revolution shows the weight or pull.

Plan of a Recording Device.

An anonymous author suggests the apparatus shown in Fig. 423. Here it will be seen that the pendulum *P* swings on the center *O*, around which a cord extends to the sample *A* held between the nippers. Attached to the nippers or holders are two pulleys around which a cord

is stretched attached to base at one end at *F*, passing over pulleys at top and around wheel on end of registering cylinder and finally ending in weight *G*. Now as the specimen stretches in the jaws it is evident that the weight *G* must rise to twice the extent of the stretching of the sample. The movement of the sample *A*, caused by the swing of the pendulum or weight *P*, will not have any effect on the length of this cord which revolves the cylinder. Nor does the weight of *G* or friction of pulleys have any influence, as this pull is transferred to the weight *G* through the grips on the sample *A*.

The recording pen is moved by the bar *D*, connected with the plate *C*, which follows out the extended end of pendulum at *B*, thus

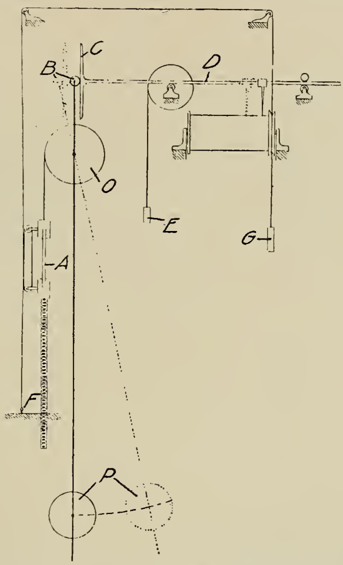


Fig. 423.—Side View of a Recording Device.

following the movements of the weight and recording it. The weight *E* pulls the pencil out through a rack and pinion on the bar *D* and the weight pulley.

The Hartford Rubber Testing Dynamometer.

This machine, Fig. 424, originated at the Bureau of Standards, at Washington. It is specifically for rubber testing and has a capacity of 125 pounds. The dial is graduated in quarter pounds and the dial hand remains at the graduation showing the maximum strain at which a test piece breaks. A 36-inch scale attached to the side of the column enables the elongation of the test pieces to be observed. The recoil

of the springs is prevented by a cramp plate, which retains them at the registered tension until returned by the operator. The returning device consists of two hooks, attached to the lower grip, which engage with pins in the upper grip when it is desired to return the dynamometer to zero. A hand wheel is attached to the worm wheel shaft for this purpose.

The upper grip swivels to compensate for any irregularities in the gripping. In the steel upright is a sliding rack to the upper end of which is attached the lower grip. Near the lower end of the rack and just above the base is the rack mechanism, driven by a motor attached to the base through cone pulleys having four steps, which

FIG. 424.—THE HARTFORD RUBBER TESTING DYNAMOMETER.

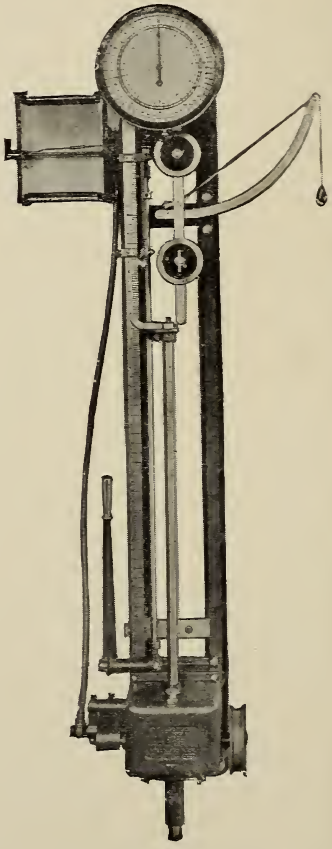


FIG. 425.—THE SCOTT TESTING MACHINE.

drive the rack and the lower grip at approximately 10, 20, 30 or 40 inches per minute. The range of movement of the rack is 36 inches.

An automatic knock-off guards the dynamometer from injury, such as might be caused by a test piece not breaking under the rated capacity of the instrument or while returning the lower grip to its normal starting position.

The instrument is equipped with a 110 volt motor, either direct or 60 cycle alternating current. Electric connection is made to the motor by an extension plug from a standard lamp socket. The motor is controlled by a switch on side of base.

The instrument is 105½ inches high and requires 20x14 inches floor space.

The Scott Testing Machine.

This machine, illustrated in Fig. 425, is built according to United States standards, on the dead weight principle. It is attached to the wall to avoid floor vibration and is driven by a 1/6 horse power motor.

The head of the machine has a dial with two rows of figures. The outer graduations range from 0 to 250 pounds, by pounds, and the inner from 0 to 50, by fifths of pounds. One hand indicates on both circles the amount of stress required to break the sample. On the swinging lever are two weights, the upper being fixed and the lower removable. Delicate tests are made by removing the lower weight and reading the inside row of graduations on the dial.

The test is started by means of the lever at the left, which causes the stretching screw to move downward at a definite speed without revolving. At the end of the stroke the tester automatically reverses and returns at high speed to its normal position, where it comes to rest ready to receive another sample. The pointer on the dial records the amount of the break and remains at that point until reset. If desired, the locking pawls may be held out of engagement with the toothed racks and an oscillating movement obtained for friction tests.

To indicate the stretch a brass scale, graduated from 0 to 48 inches, is attached to the frame at the left. The scale is adjusted up to bring the 0 mark to any desired point. Upon the scale are placed two sliding pointers, which are easily moved by hand to follow marks upon the sample. To the lower pointer is attached a special flexible tape in a round metal case which automatically winds and unwinds as the distance between the pointers varies. This tape gives the net stretch between any two marks on the sample. Near the tape at the

left is an automatic registering or charting device designed to hold a standard size letterhead on a flat platen by means of two rubber covered rolls. The break and stretch is recorded in ink on this sheet, which is then placed in a typewriter to receive further data for record. Several tests may be recorded on the same sheet to demonstrate variation in different samples. The movements of this recording mechanism are automatically begun when the starting lever of the machine is operated and automatically stopped when the machine is reversed.

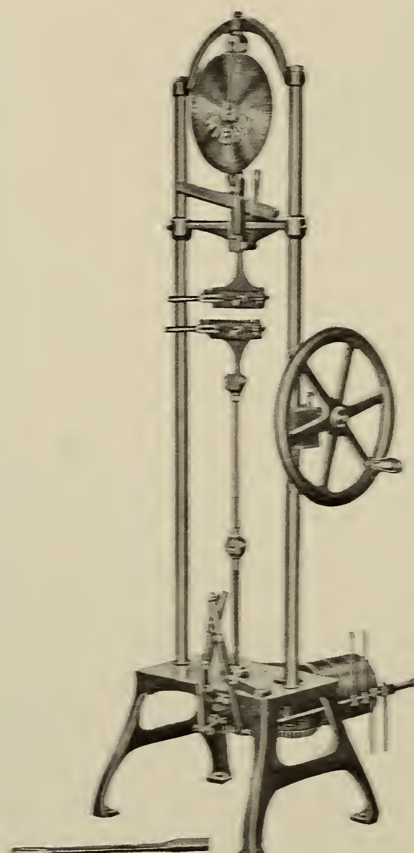


FIG. 426.—THE RIEHLE ARCH POWER MACHINE.

Textile Testing Machines.

The textile fabrics embodied in rubber goods are designed to give the finished product the element of strength. Hose and belting are notable examples of rubber goods designed to withstand heavy strains in service. The element of strength is also important in such lines as footwear and clothing, carriage cloths, tires, and many other lines. As fabrics vary greatly in stretch and tensile strength testing machines are a necessity. Such tests are made on a number of well known machines. Test pieces previously stored so that the moisture is constant are cut with their length parallel to both warp and weft. These pieces are about 7 inches long and 2 inches wide. Several pieces are tested in each direction and about one-half of the breaking load figured as the tensile value.

Riehle Arch Power Machine.

In Fig. 426 is shown the Riehle "Arch Power" testing machine. It has a capacity of 600 pounds pull and may be operated by either hand or belt power. The power mechanism consists of a worm and gear driven by pulleys through straight and crossed belts. A lever disengages the worm and the machine can then be operated by the hand wheel. The strain is measured by a standard spring balance and the recoil is taken up by a pair of wedges which follow the downward pull and prevent shock to any extent. An idle index indicates the maximum load or breaking strain of the specimen.

Falkenau-Sinclair Fabric Testing Machine.

The vertical form of machine as built by the Falkenau-Sinclair Co. (Fig. 427) is arranged for hand power operation only. The strain is applied to the cloth by means of worm gearing and is indicated by a maximum hand on the dial of a spring balance, and the recoil of the balance is obviated by a following up wedge, as in the "Arch power" machine. The hand lever shown immediately under the dials in both forms of machine is for controlling the release of the spring of the balance when the wedge system in the rear is disengaged. For rapid work the worm can be thrown out of gear and the screw run up or down rapidly by the hand wheel. The machine is built in two sizes for 200 or 600 pounds capacity.

Olsen's Fabric Testing Machine.

The machine, illustrated in Fig. 428, is designed to cover the requirements for an automatic textile tester where accuracy, ease of operation and rapidity are important factors.

The cloth is held in the heads by quick acting grips which will accommodate test pieces up to 3 inches wide. The machine weighs automatically, and the pointer remains stationary at the point on the scale at which the test piece breaks. The motor driven worm wheel at the end of the machine is for applying the load. It can also be applied by the hand wheel. The rack is for holding the pendulum at the point of rupture until returned to the starting position by the hand crank.

Two machines are embodied in the one, in that the capacity may be readily changed from 300 pounds (1 pound increments) to 600

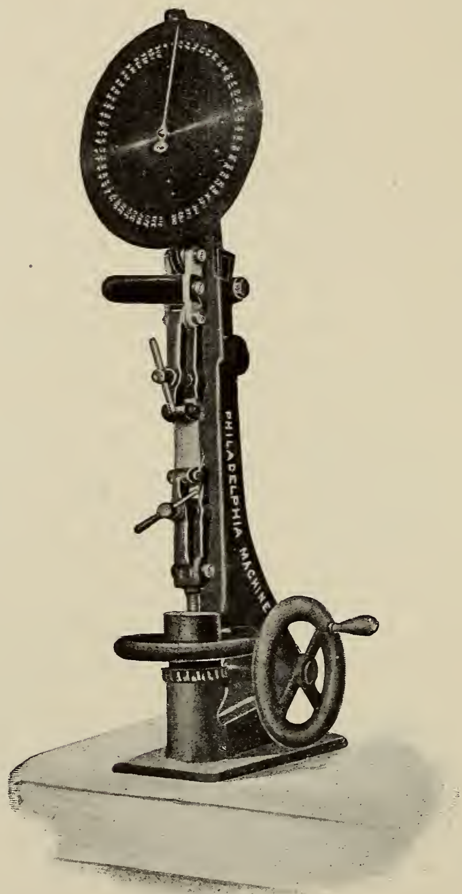


FIG. 427.—FALKENAU-SINCLAIR FABRIC TESTING MACHINE.

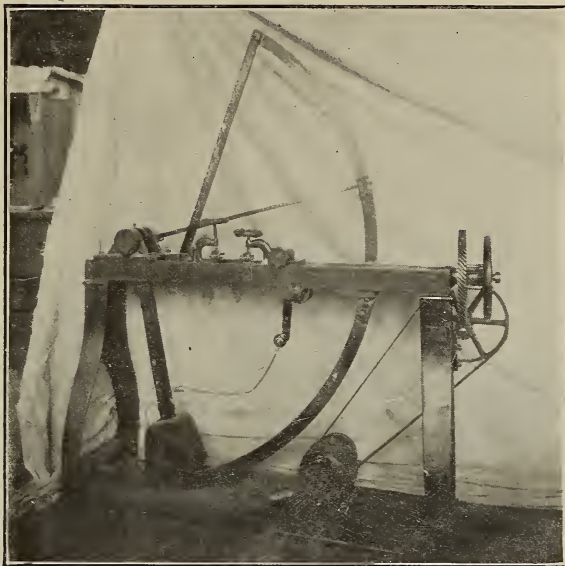


Fig. 428.—The Olsen Fabric Testing Machine.

pounds (2 pounds increments) by changing the weight of the pendulum, and on the large sized machine from 400 pounds to 1200 pounds capacity.

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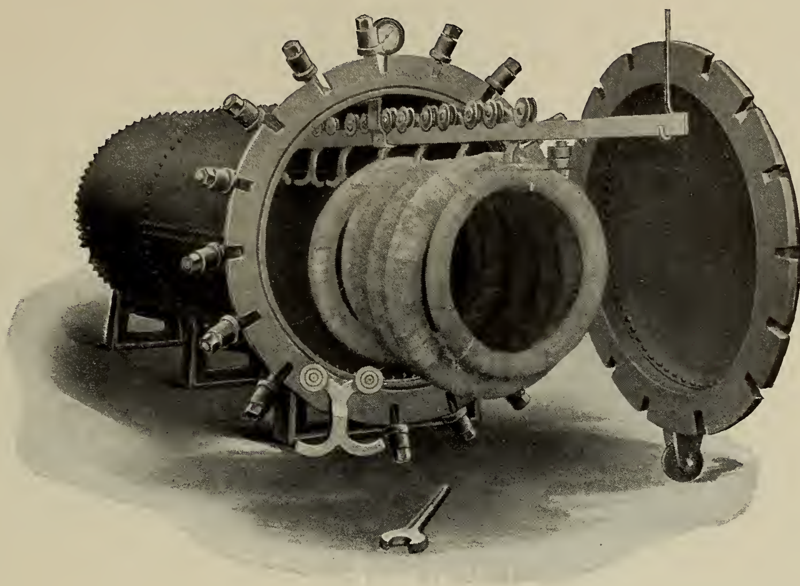

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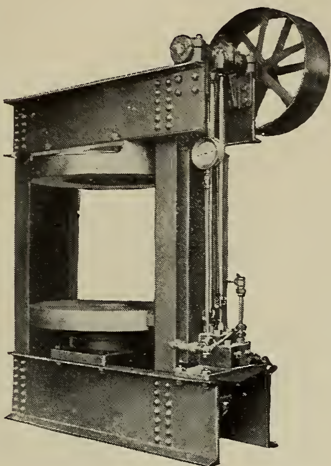

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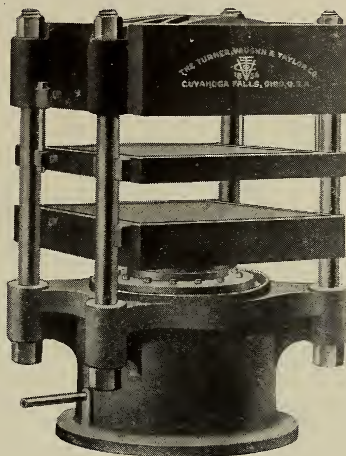

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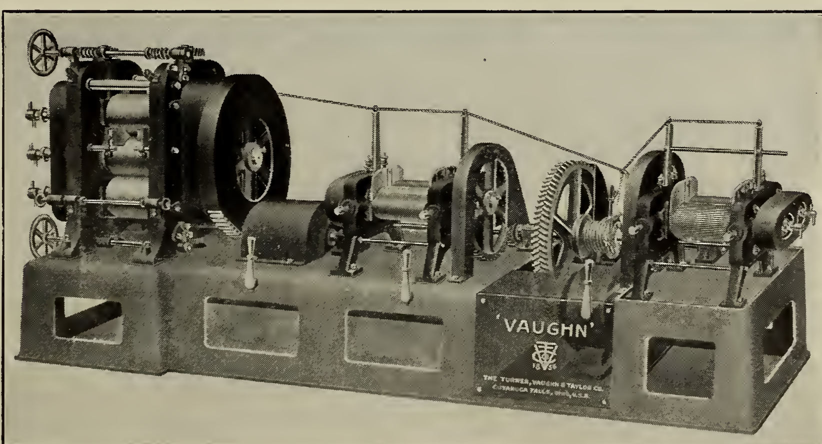

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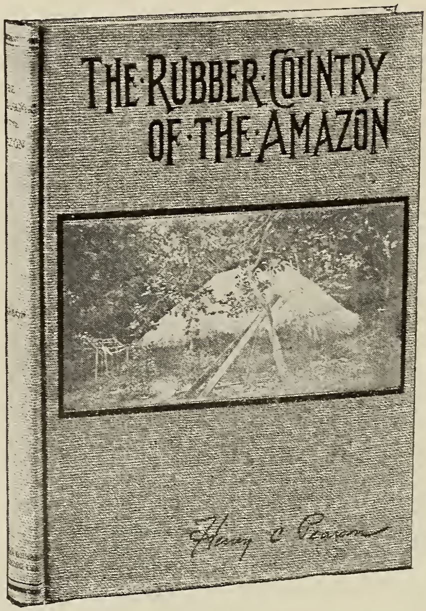

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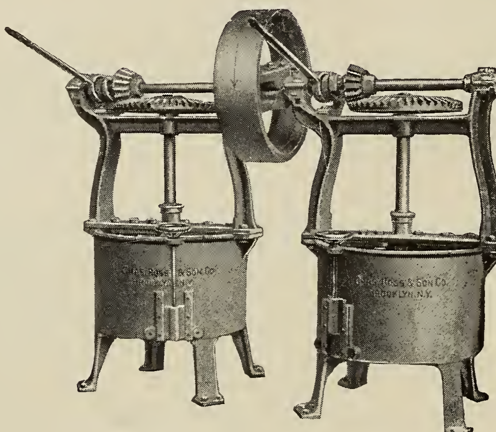

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(HENRY C. PEARSON, Editor)

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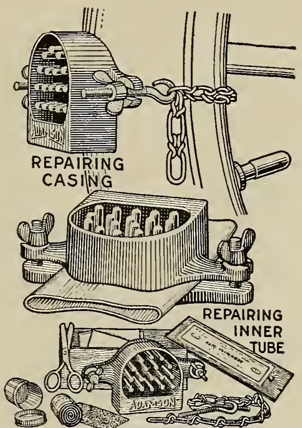

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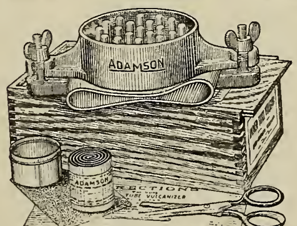

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